BUILDING AN INTERNATIONAL INTEGRATED PRA MODEL

. . . ACROSS OCEANS AND INTERNATIONAL BOUNDARIES

Mike Lutomski
Risk Manager - International Space Station

Trilateral Safety & Mission Assurance Conference 2008
15 April 2008

Recent ISS Accomplishments and Look-Ahead

- International Accomplishments
  - Docked Expedition 17 Soyuz Crew
  - Node 2 – Harmony (ASI - Italian) Dec 07
  - ESA's Columbus Laboratory (Feb)
  - Flight 1J/A Delivering first element of Kibo
    - ELM-PS
  - First Flight of New European Resupply Vehicle (ATV) – Jules Verne
- Look-Ahead
  - Kibo – Pressurized Module (PM) - April
  - Increase Crew Size from 3 to **6**

16 Soyuz – 16S

- April 8th, 2008


ВОЛКОВ • КОНОНЕНКО
REISMAN • CHAMITOFF • MAGNUS
ISS-17

Increment 17

- Sergei Volkov, Commander and Oleg Kononenko, FE-1

With Special Guest . . .

So-yeon Yi – South Korea's First Astronaut

Launched April 8th, 2008

Sergei Volkov and Oleg Konenenko
Docked April 10th, 2008 joined

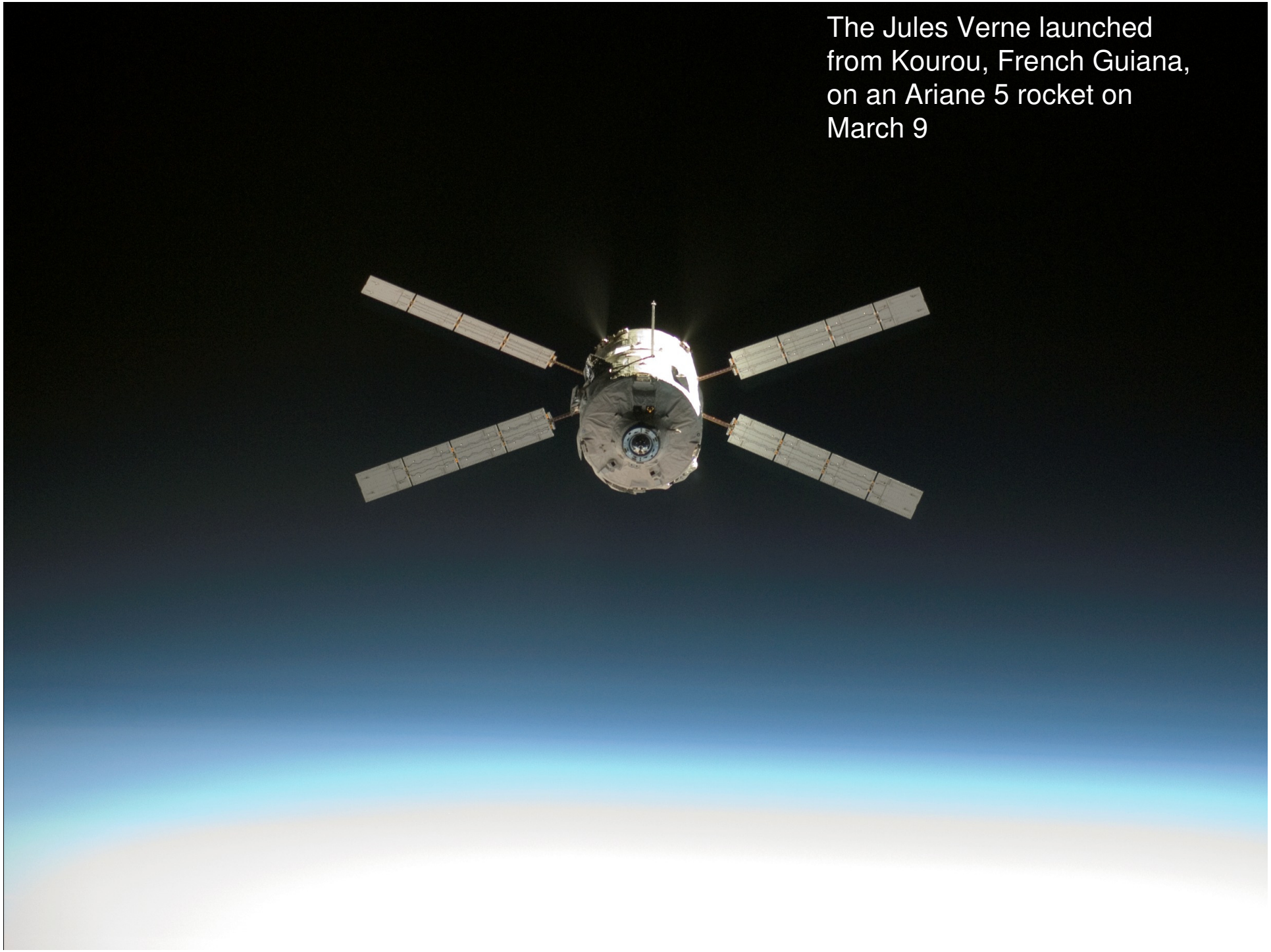
Garrett Reisman
already Onboard
since mid-March

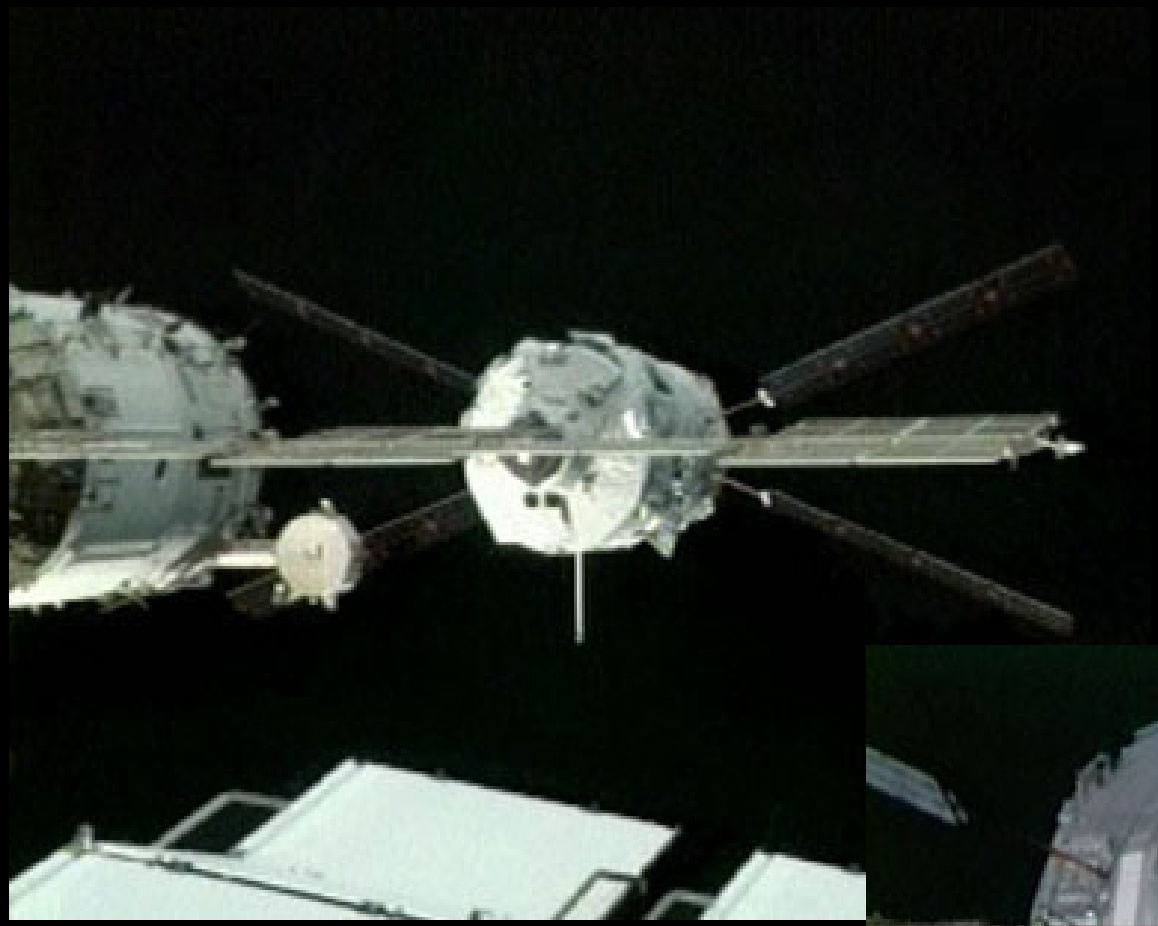
Greg Chamitoff
Arriving on 1J with
the JEM PM
~ May/June

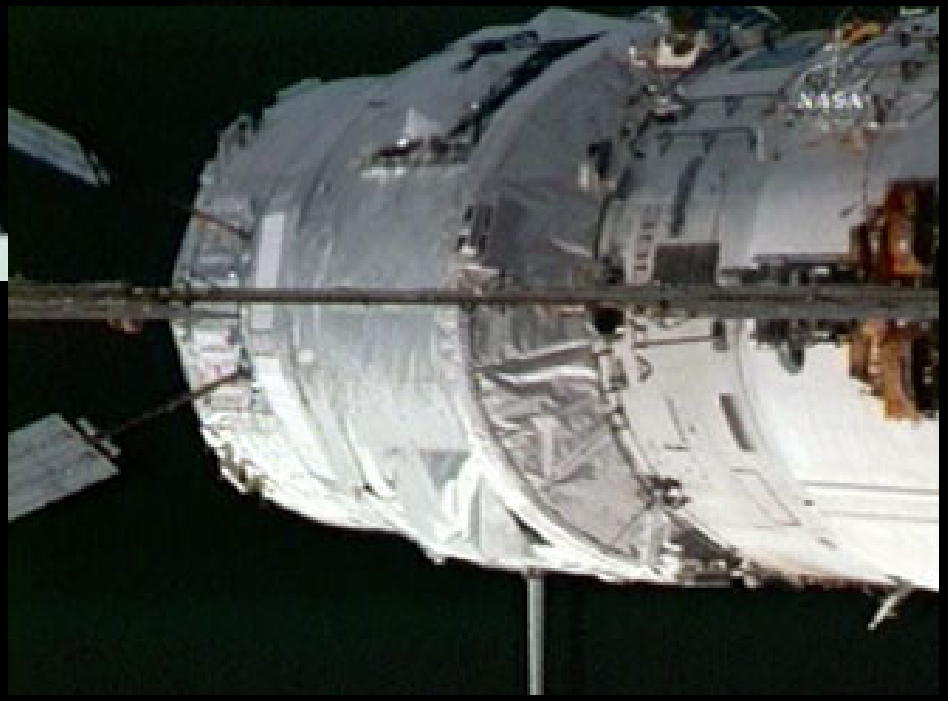
Sandra Magnus
arriving on ULF-2
~ September

South Korean Yi So-yeon

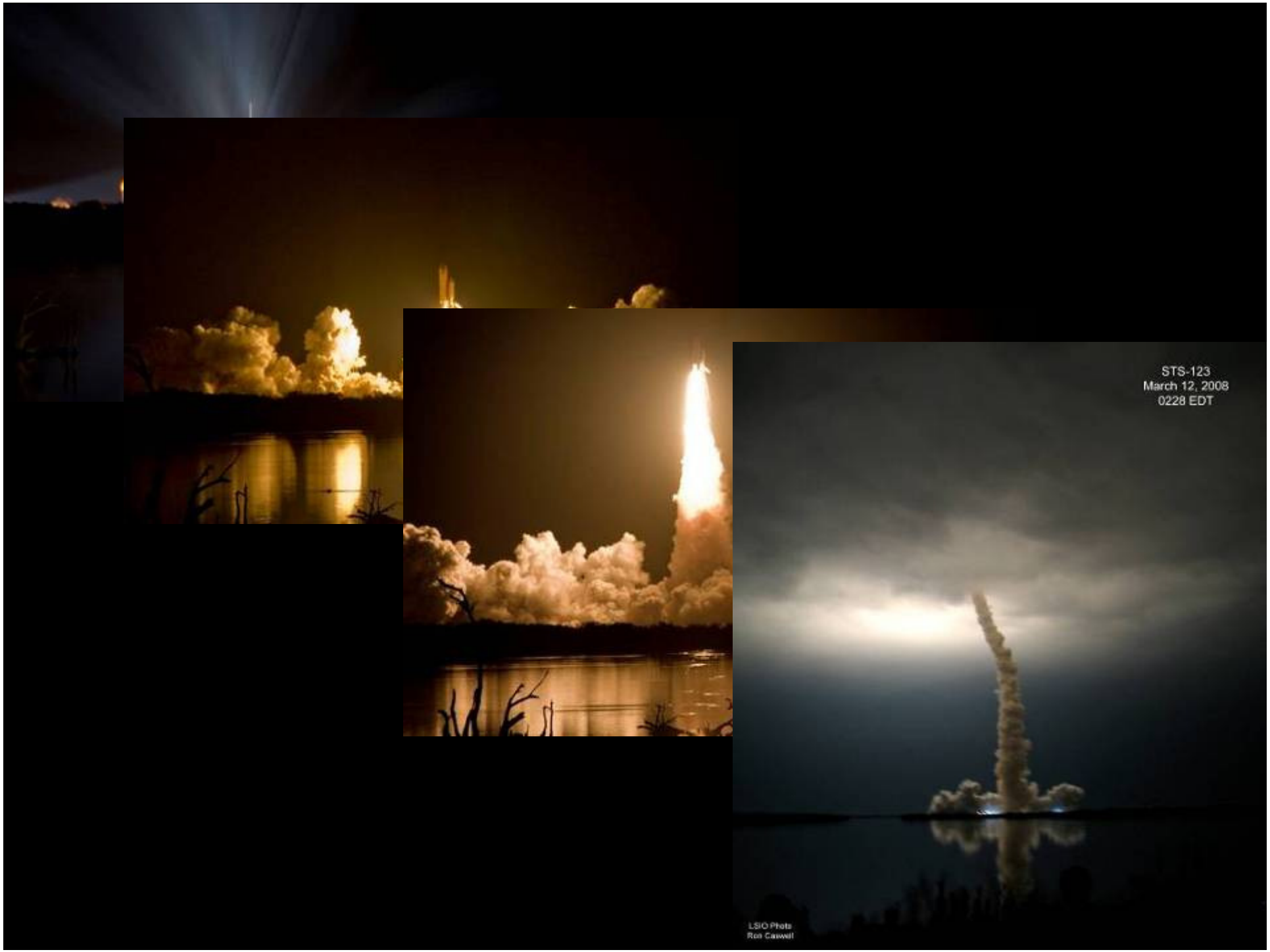
- First South Korean in space
- Second Asian woman to fly in space
- Ph. D student at Korea Advanced Institute of Science and Technology in Mechanics
- 29 years old

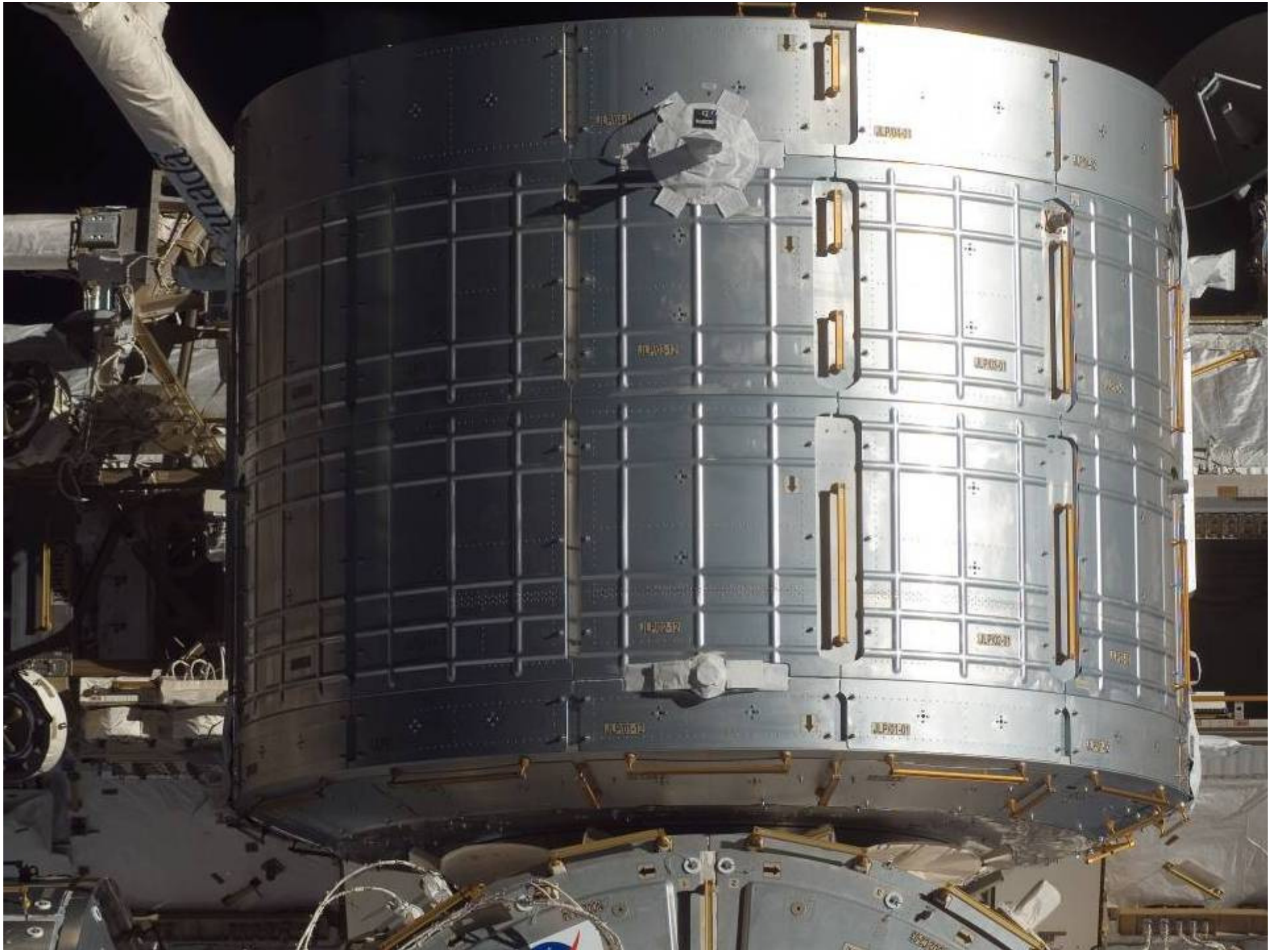

The Jules Verne launched
from Kourou, French Guiana,
on an Ariane 5 rocket on
March 9



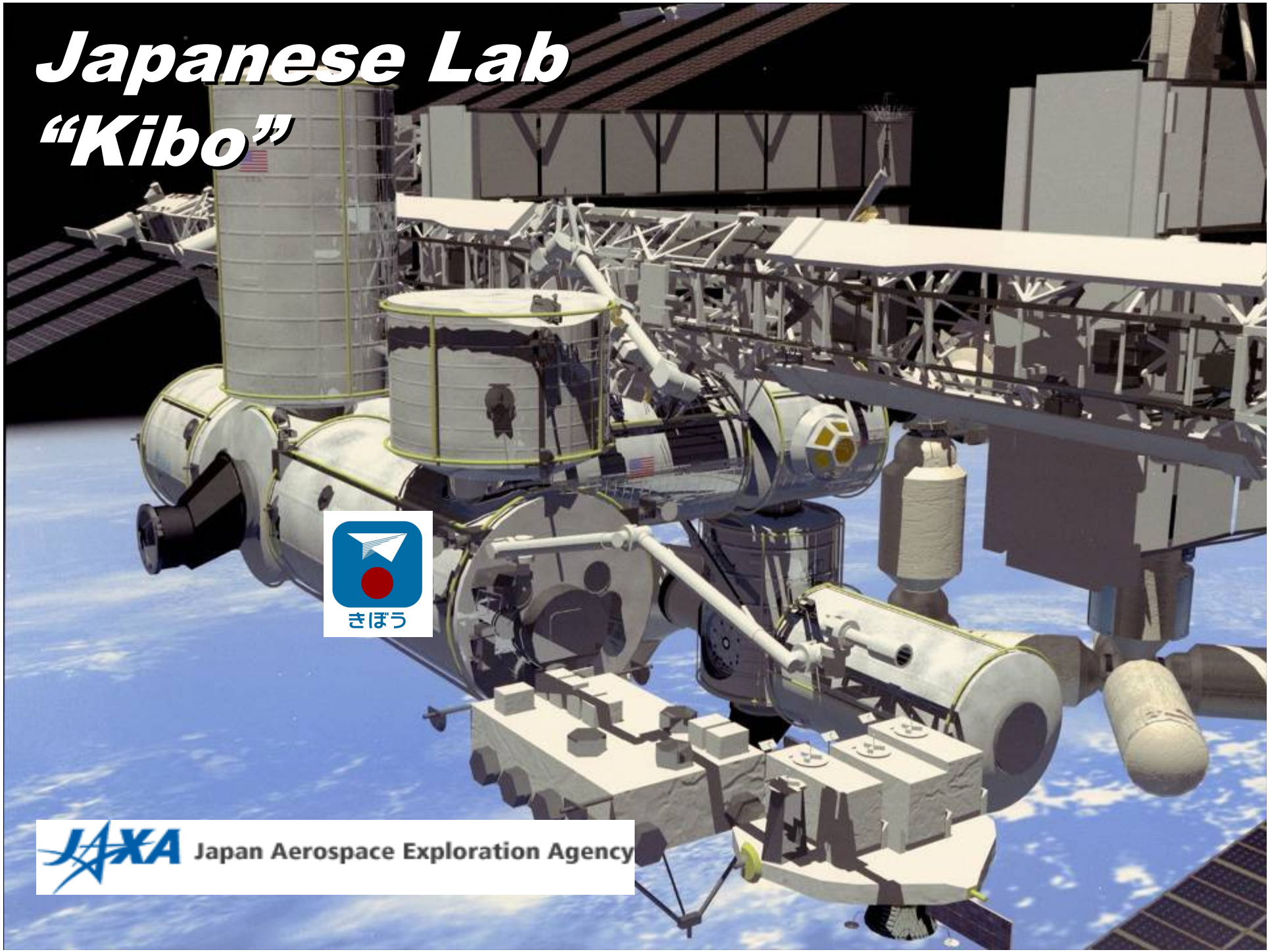


Jules Verne – ATV1
- April 3rd, 2008

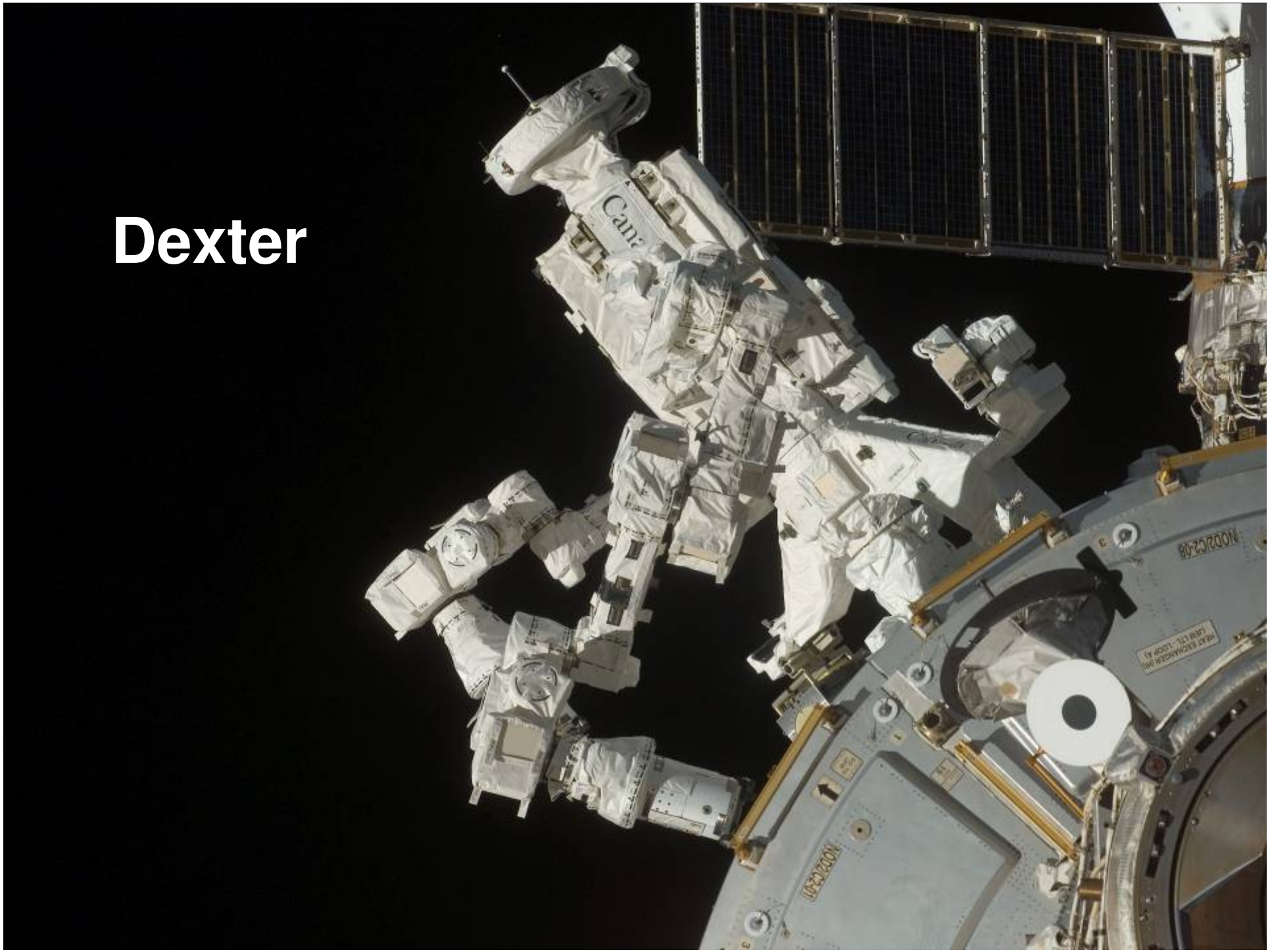

STS-123
March 12, 2008
0228 EDT
LSIO Photo
Ron Caswell

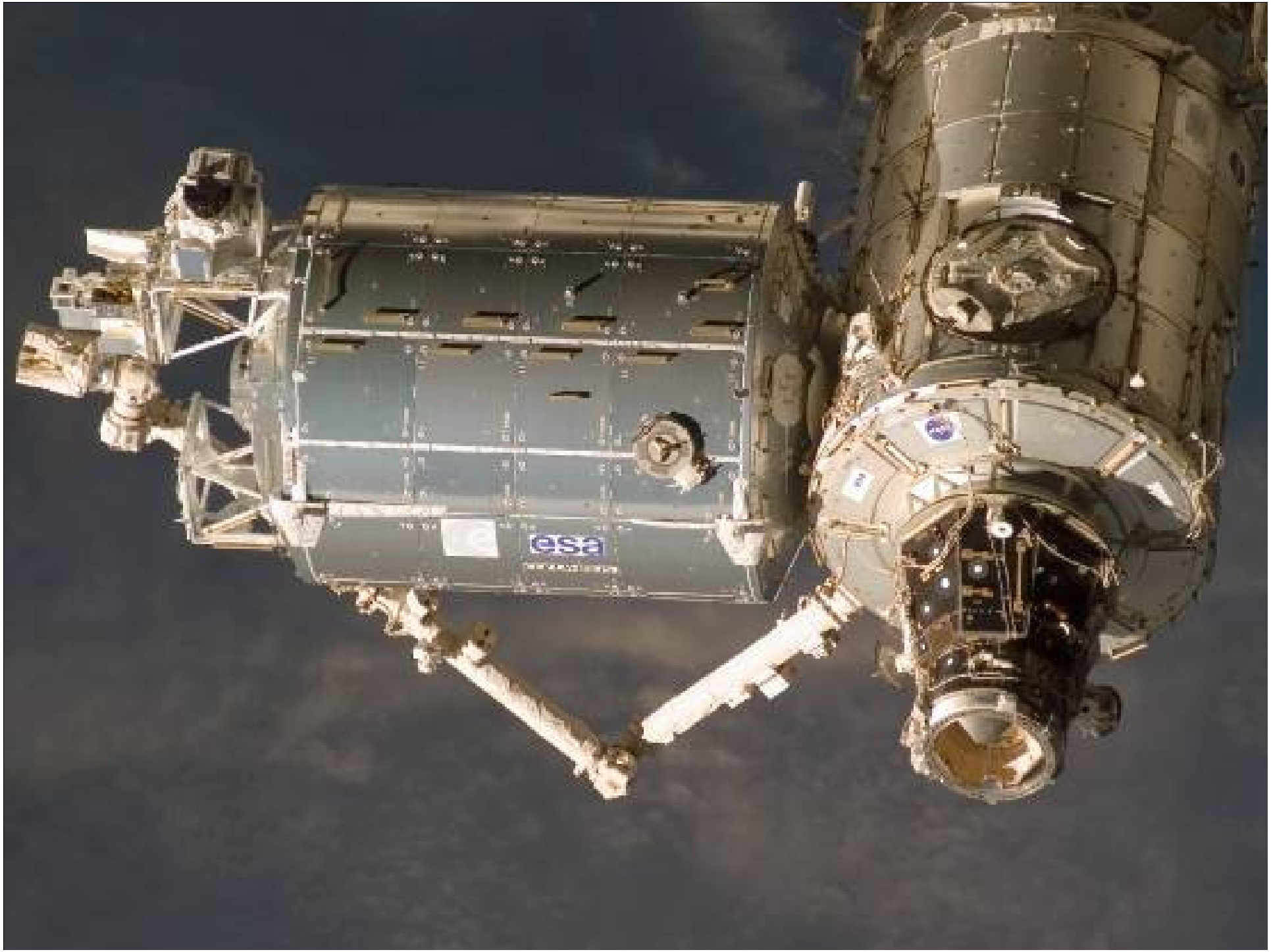


Japanese Lab "Kibo"



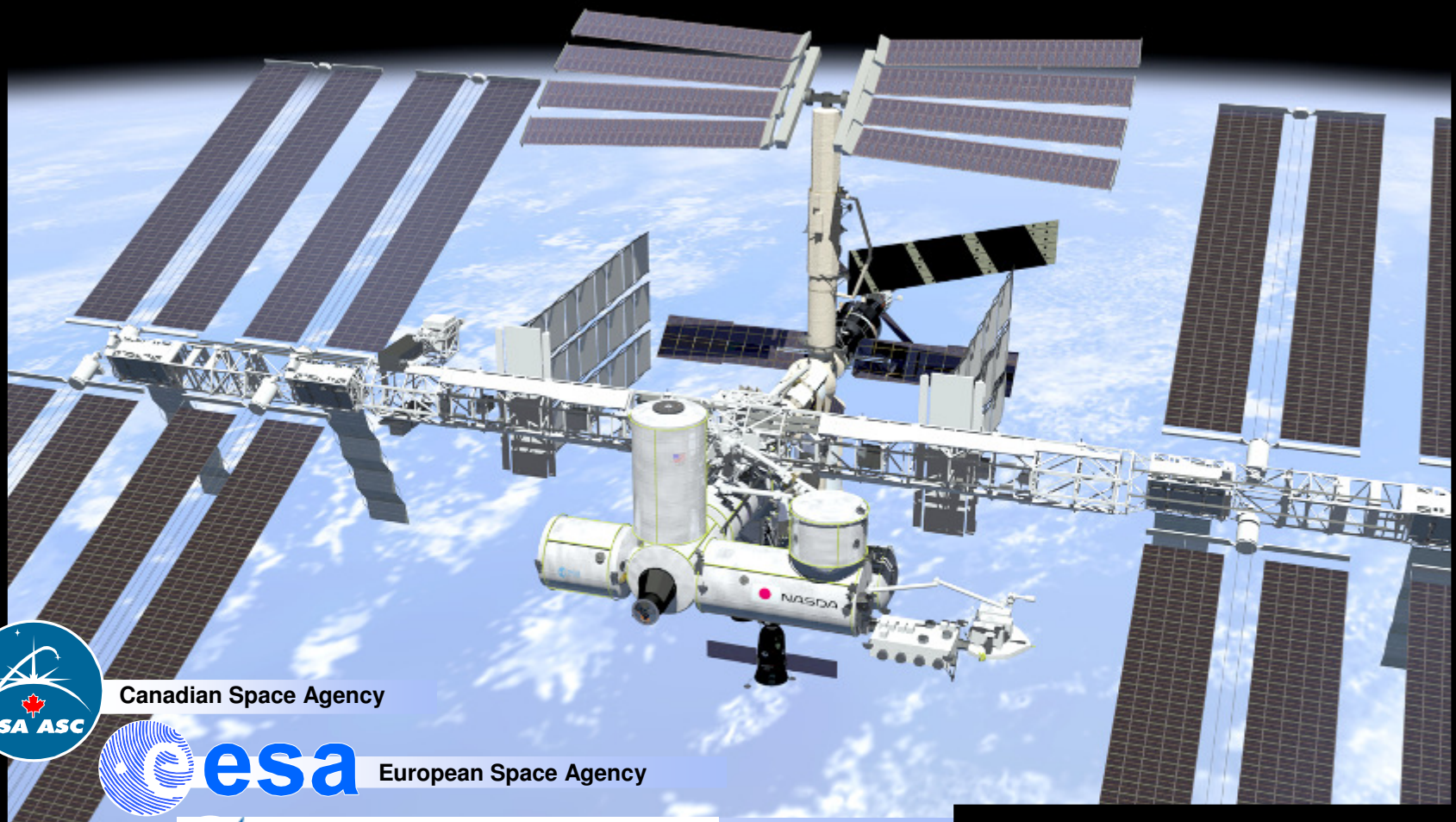
Dexter




esa

Atlantis

ISS International Partnership



Canadian Space Agency

European Space Agency

Japan Aerospace Exploration Agency

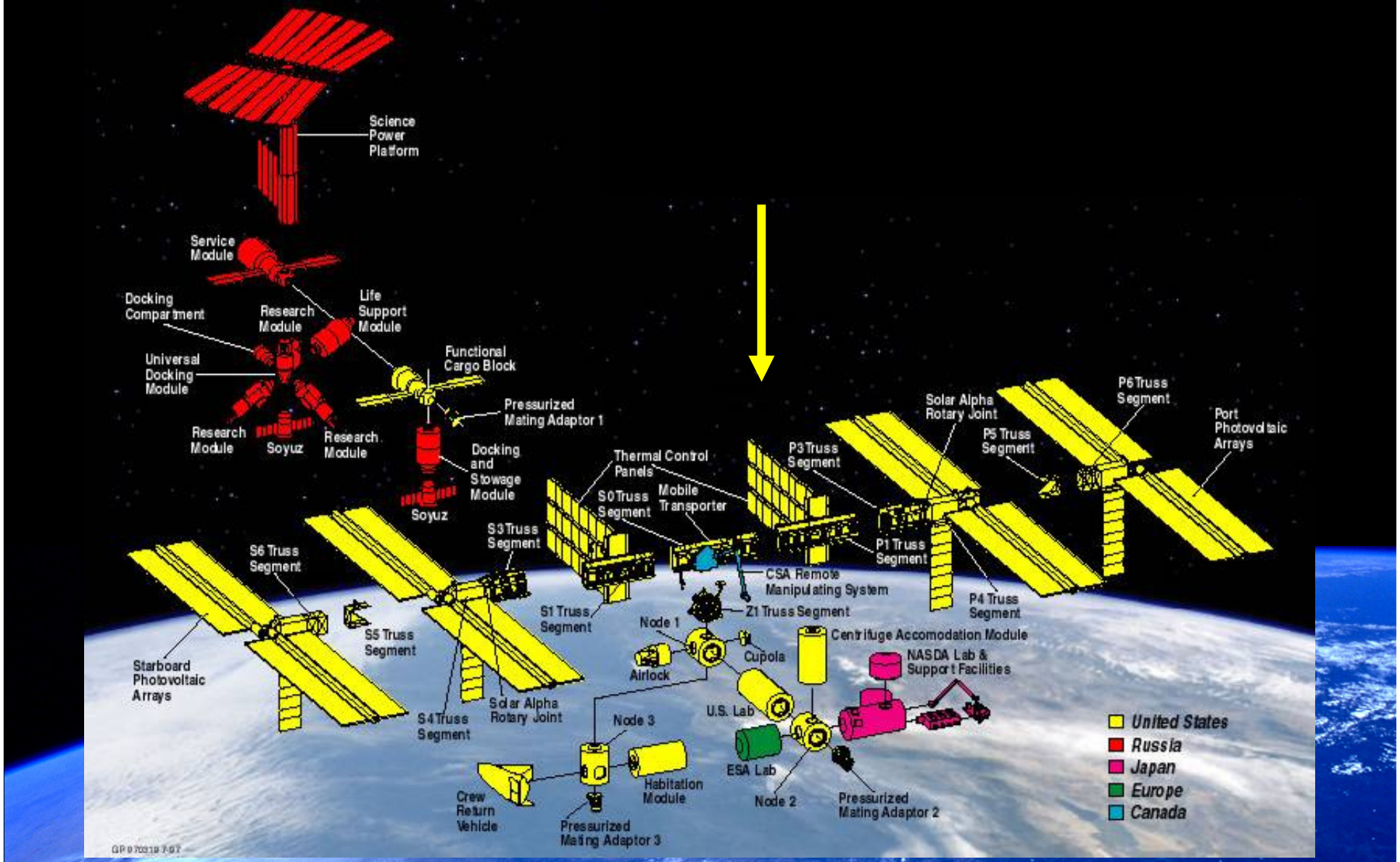
Federal Space Agency (Russia)

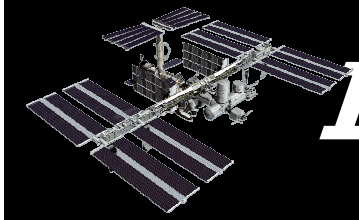
National Aeronautics and Space Administration

INTERNATIONAL SPACE STATION

What's Ahead US Segment

(Baseline)





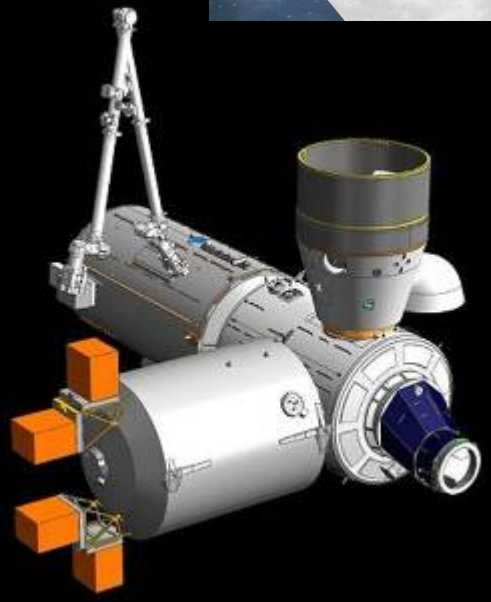
ISS Launch Vehicles

Shuttle

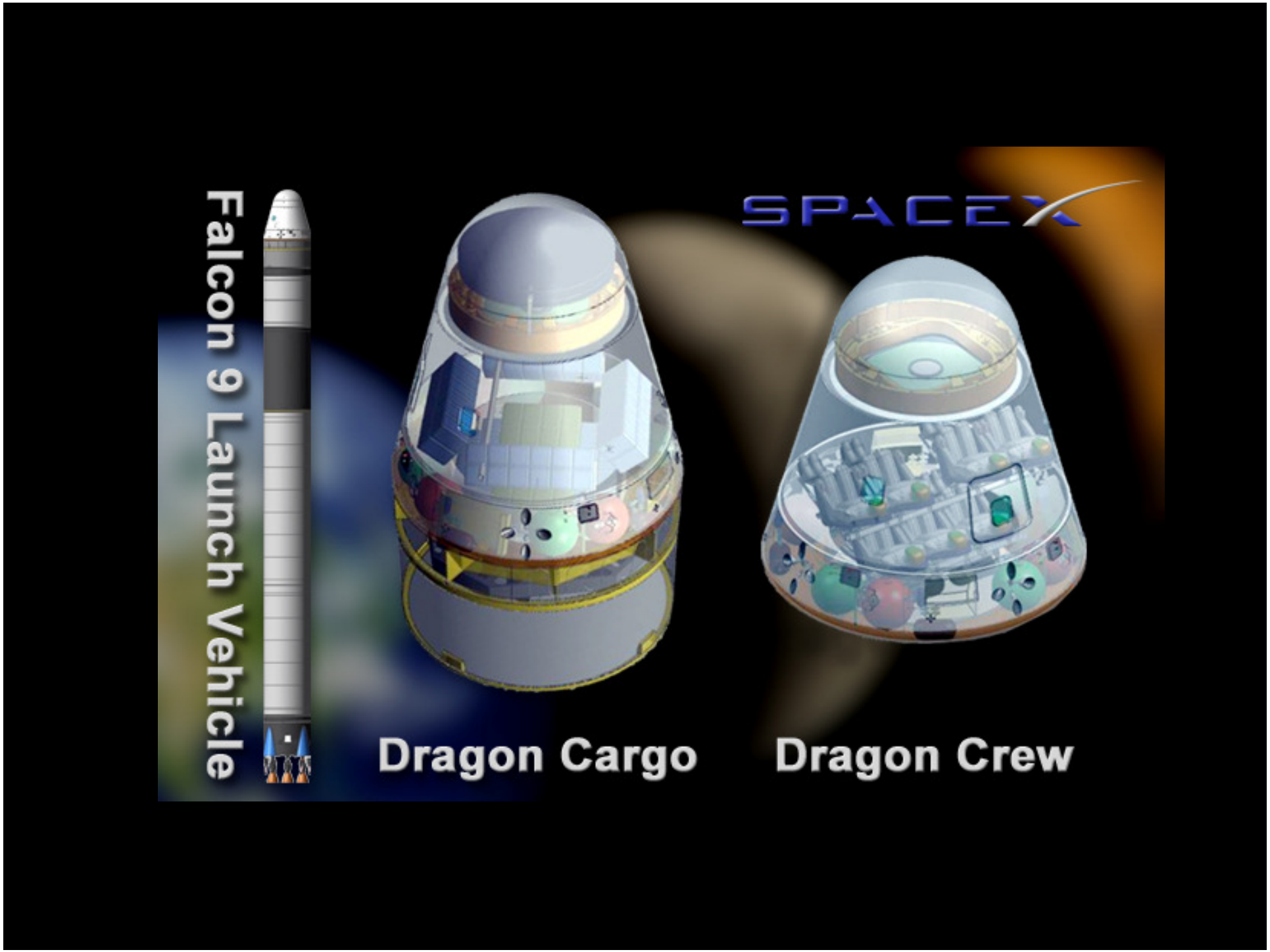
Proton Soyuz

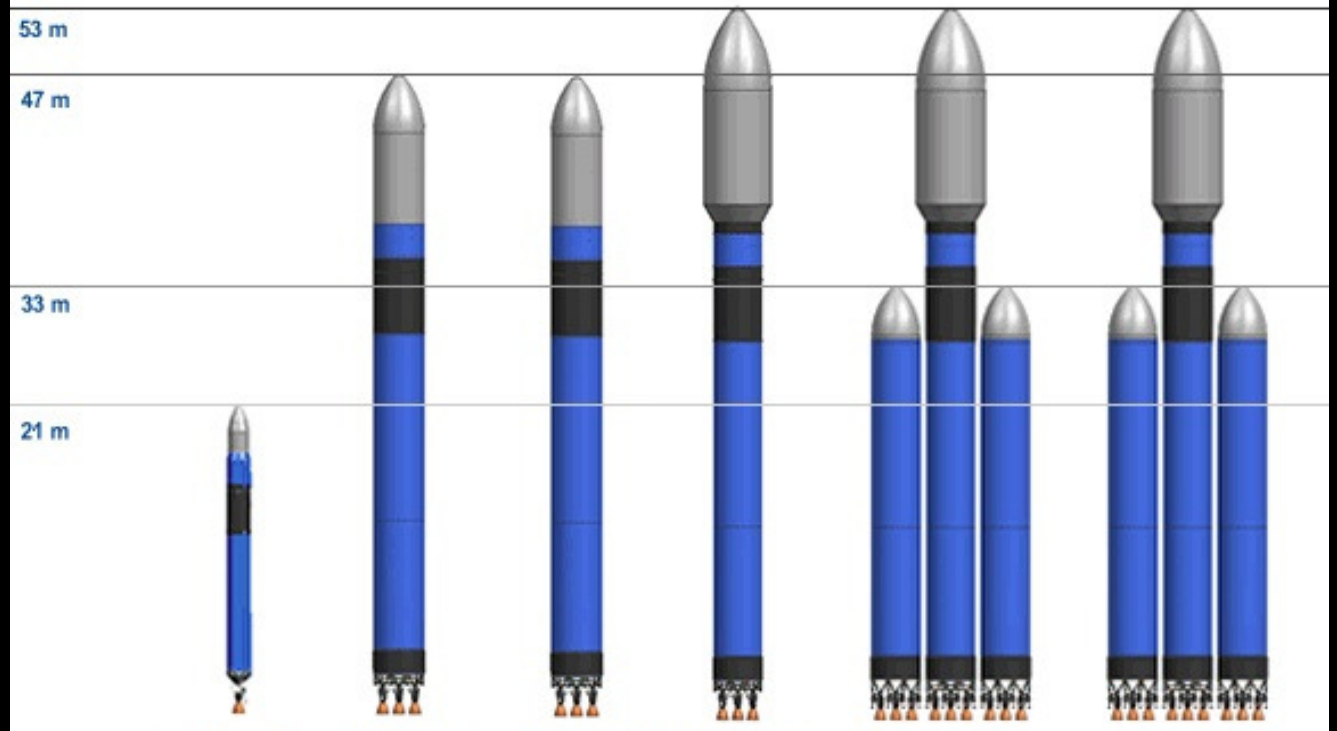
Ariane & ATV

HIIA & HTV



Elon Mush – PayPal Founder
36 years old - $328 MM


Falcon 9 Launch Vehicle
SPACEX
Dragon Cargo
Dragon Crew



	Falcon 1	Falcon 5	Falcon 9	Falcon 9	Falcon 9 - S5	Falcon 9 - S9
LEO	570 kg	4,100 kg	9,300 kg	8,700 kg	16,500 kg	24,750 kg
GTO	--	1,050 kg	3,400 kg	3,100 kg	6,400 kg	9,650 kg
Fairing diameter	1.5 m	3.6 m	3.6 m	5.2 m	5.2 m	5.2 m
Price in millions *	$6.7	$18	$27	$35	$51	$78

* Prices are all inclusive of launch range, third party insurance and standard payload integration costs.

Omelek Launch Facility

Falcon 1 on the Pad

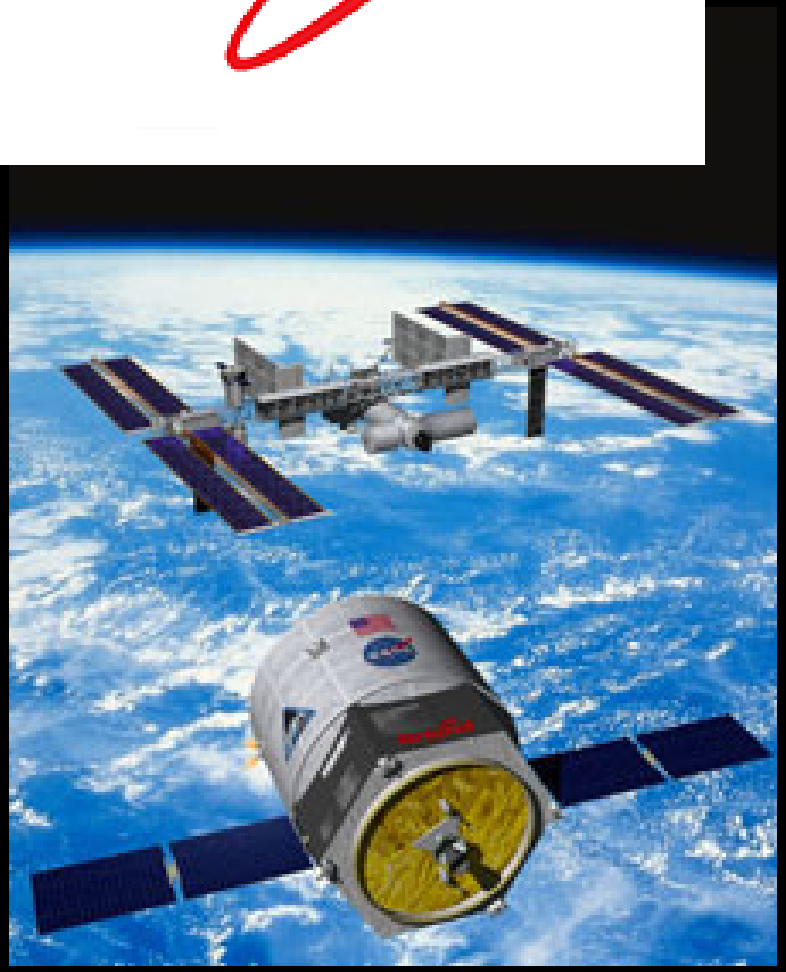
IBAY - Omelek

Fiber Room - Omelek

Falcon 1 in the Hangar

Falcon 1 Ready to Launch

Orbital



Blue Origin

Virgin GALACTIC

- The vehicle will have room for five passengers
- A week's pre-flight training will be required
- Three-hour trip; three minutes of weightlessness
- Flights to leave from Mojave Desert, initially
- Tickets to cost about £100,000, perhaps less


Virgin


Virgin
Virgin


Richard Brift's TCF.NET
GALACTIC

Qualitative –
Continuous Risk Management

ISS Top Program Risk Matrix

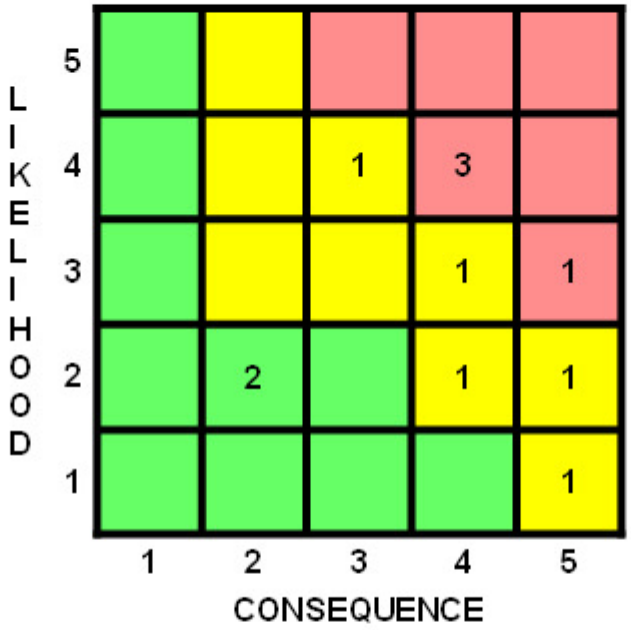
Post April 19, 2006 PRAB

Watch Items

- ▲ 4414 - Crew Rotation, Assembly, Docked, and Stage Timelines - *(CA)* - CA, DA, MA, OC, OE, OM, OX, SA
- ▲ 5246 - ISS Contingency Shuttle Crew Support (CSCS) - *(OC)* - CA, DA, EA, MA, OA, OC, OE, OM, OZ, SA
- ▲ 5184 - ISSP USOS Cargo Transportation Shortfall - *(OM)* - CA, DA, EA, OB, OC, OE, OM, OX, OZ, SA, XA
- ▲ 4706 - ISS REPLAN - Environmental Health Water Quality Monitoring - *(SA)* - CA, EA, OA, OB, OC, OE, SA

Continual Improvement

- CoFR Process
- CM Template



Low	Medium	High	
C – Cost	S – Schedule	T – Technical	Sa – Safety
▲ – Top Program Risk (TPR)			
△ – Proposed Top Program Risk (TPR)			

Changes at April 19, 2006 PRAB

Closed Watch Item 5220 – STaR: Shuttle Transition & Retirement Impacts to ISS

Risks (L x C)

Score: 3 x 5
- ▲ 2810 - Russian Segment capability to provide adequate MM/OD protection - *(OM)* - (C,S,T)

Score: 4 x 4
- ▲ 5276 - Crew Time for Research - *(OC)* - (S)
- ▲ 5293 - ATV/HTV Export Control Issues - *(OX)* - (C,S,T)
- ▲ 5456 - Overhead (Non-Procurement) Impacts - *(OH)* - (C,S,T)

Score: 2 x 5
- ▲ 4671 - ISS Replan - ISS Continued Manning - *(OC)* - (S,T)

Score: 4 x 3
- ▲ 3896 - On-Orbit Stowage Short-Fall (Pressurized Volume) - *(OC)* - CA, DA, OC, SA - (T)

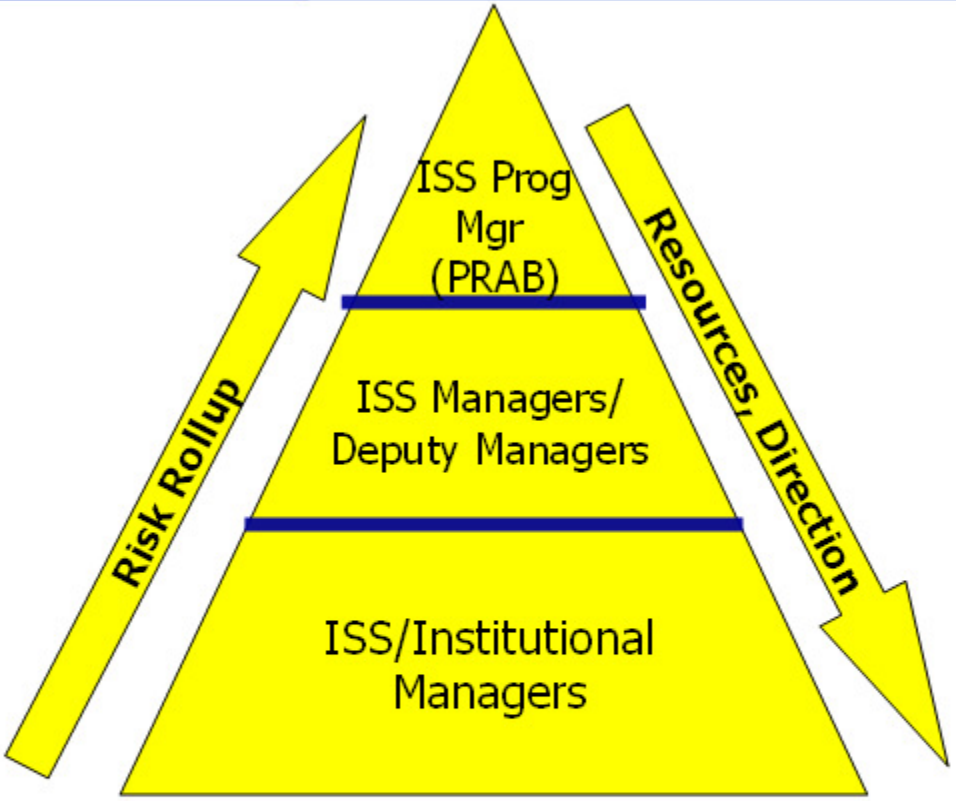
Score: 3 x 4
- ▲ 4118 - Internal Active Thermal Control System (IATCS) Coolant Impact to System Integrity (OB3) - *(OB)* - (C,S)

Score: 1 x 5
- ▲ 5590 - Risk of Trailing Umbilical System IUA TDA Removal - *(OB)* - OB - (C,S,T,Sa)

Score: 2 x 4
- ▲ 4707 - ISS REPLAN - Environmental Health System - Air Quality Monitoring - *(SA)* - CA, EA, OA, OB, OC, SA - (C,S,T,Sa)

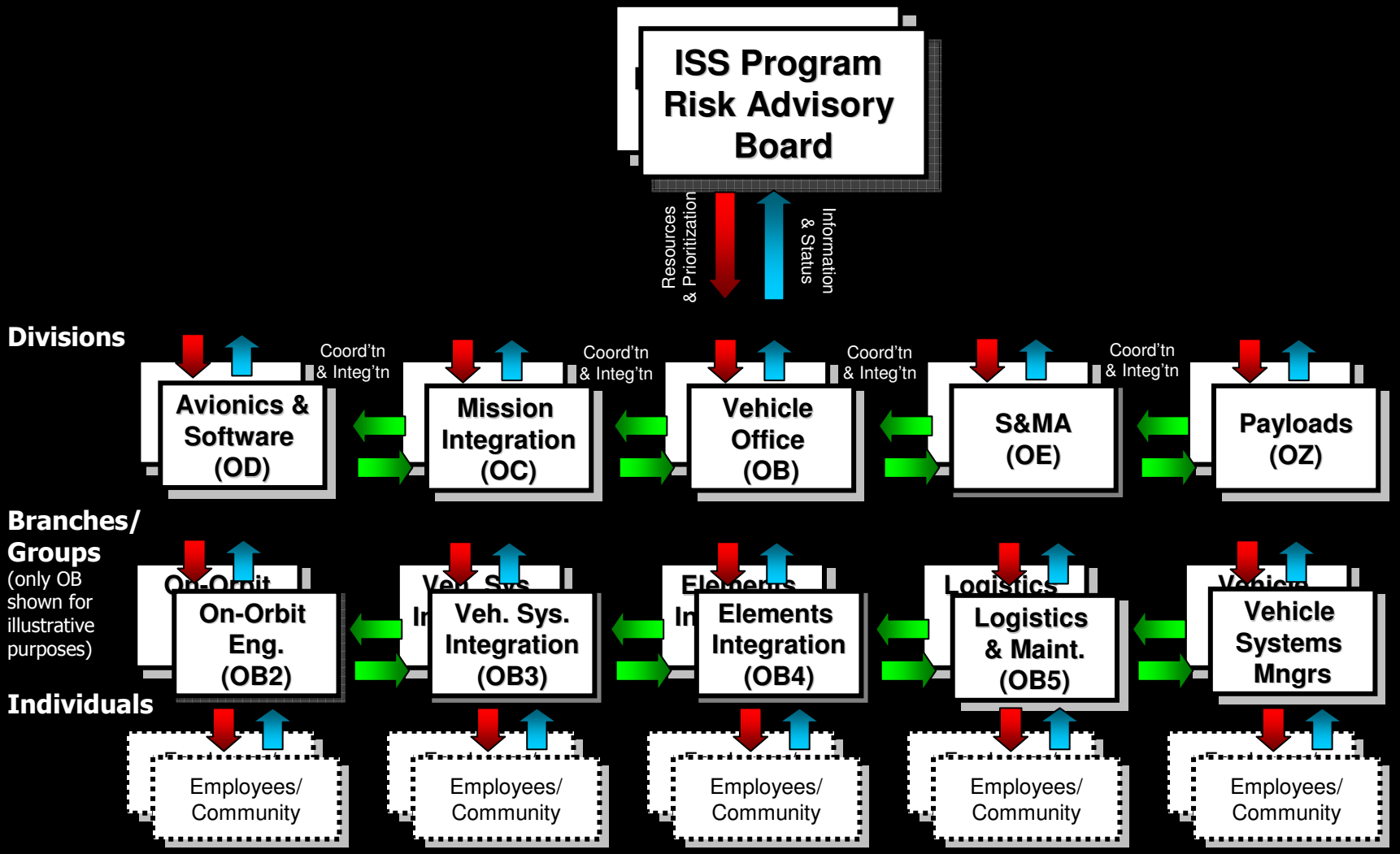
Score: 2 x 2
- ▲ 3928 - GN&C - CMG Issues - *(OD)* - DA, OC, OD, OE - (C,S,T)
- ▲ 5017 - Iran Non-Proliferation Act and the Inability to Procure Crew Support Services (rotation and rescue) from Russia - (OX) - (T)

Continuous Risk Management

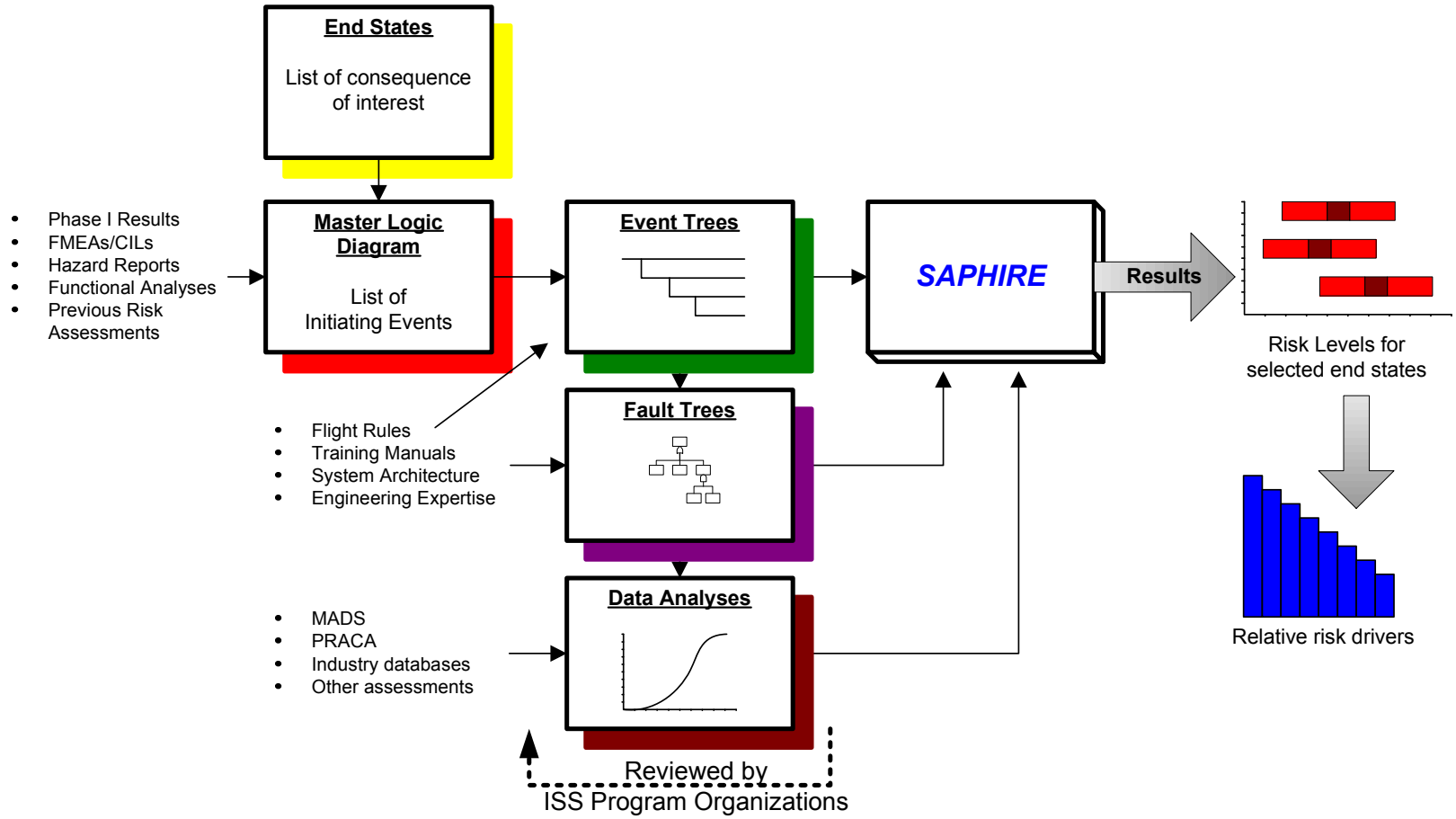


- *As opposed to managing action items, a structured approach to managing risks allows a project to take care of risks before they become problem*
- *It provides a framework upon which a project can build a tailored plan to manage project-specific risks*

Imbedded into ISS Board Structure



Quantitative / Probabilistic Risk Assessment

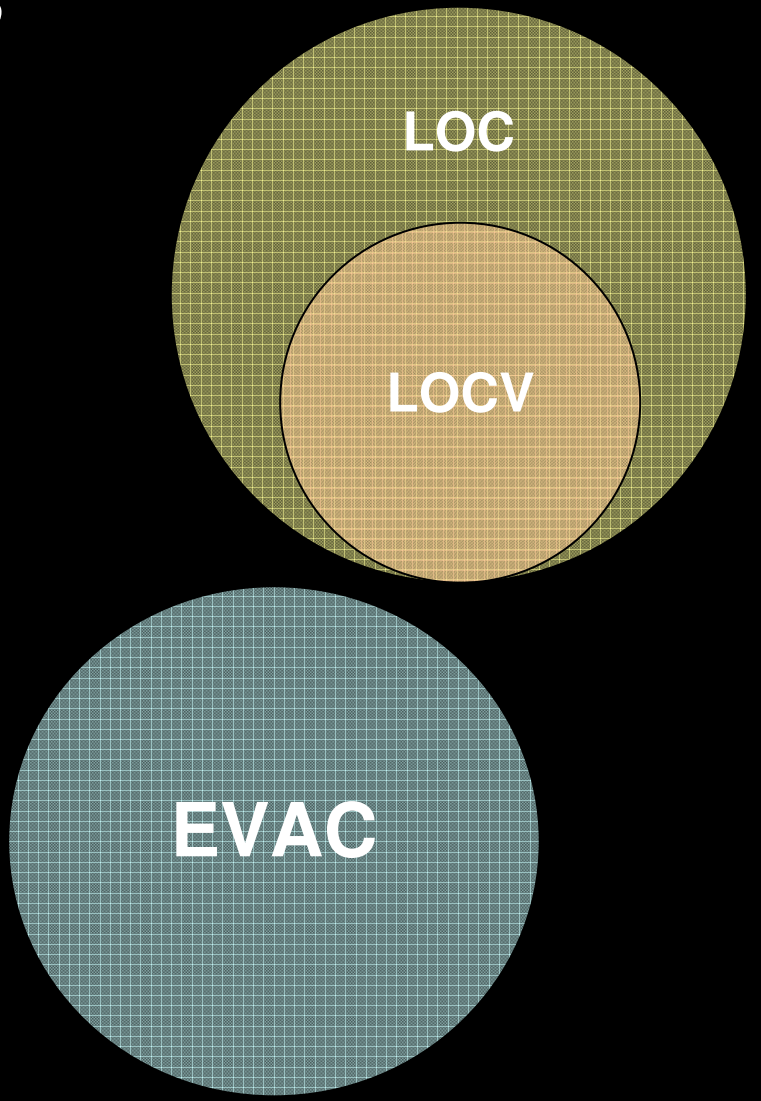


Relationship of Top ISS PRA End States

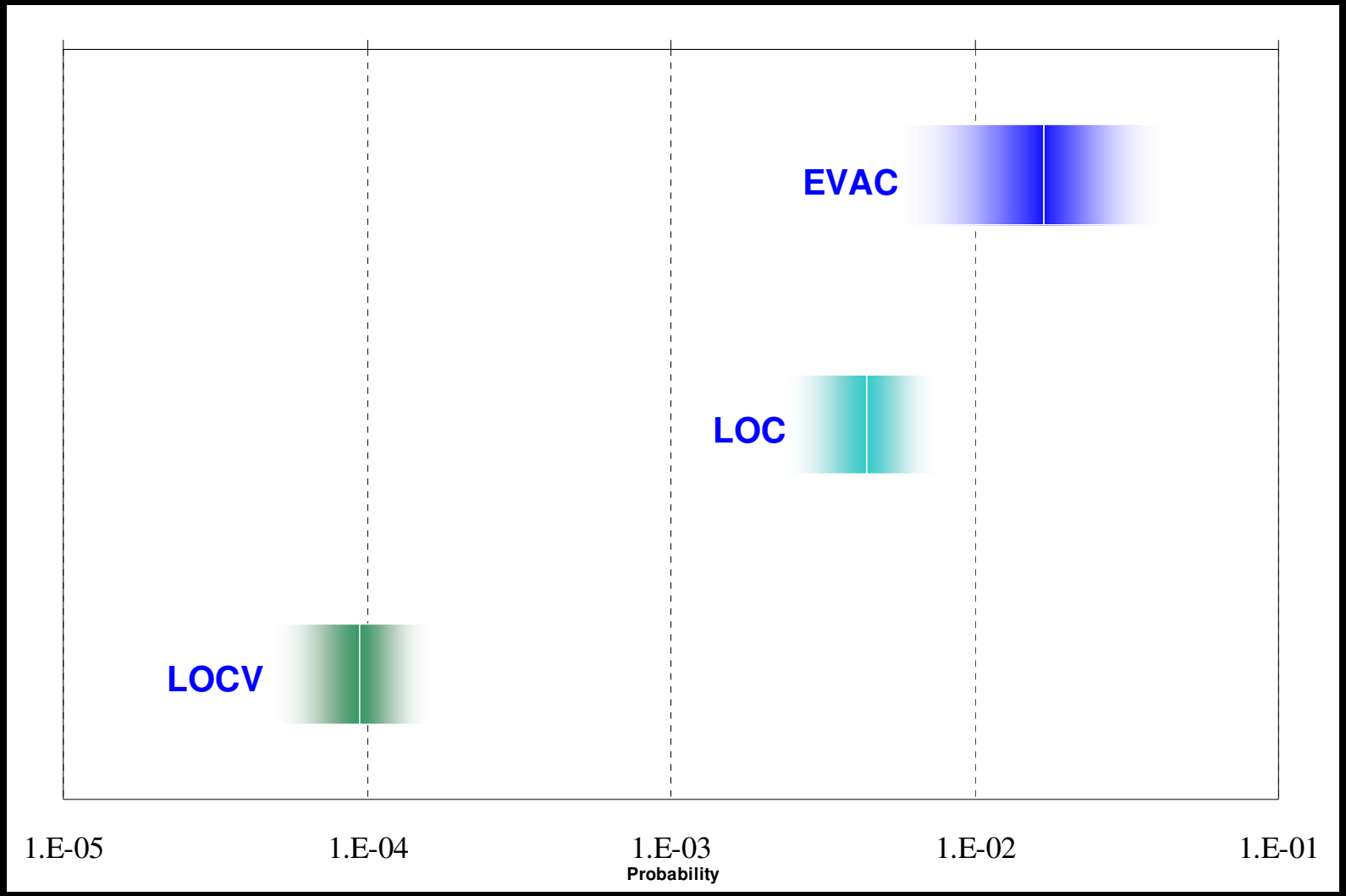
LOC – Loss of one or more crewmembers

LOCV – Loss of Crew & Vehicle (sudden event with no time for evacuation or corrective action)

EVAC – Crew Evacuation

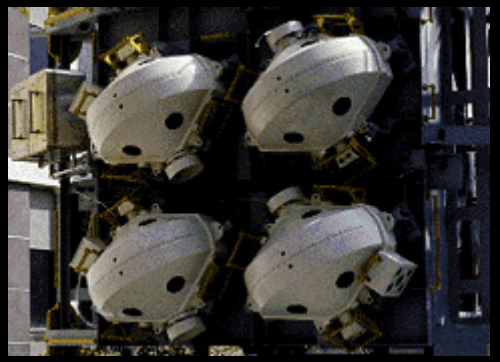


ISS PRA Ver 1.2 LOC, EVAC and LOCV (6 months)



ISS PRA Trade Studies

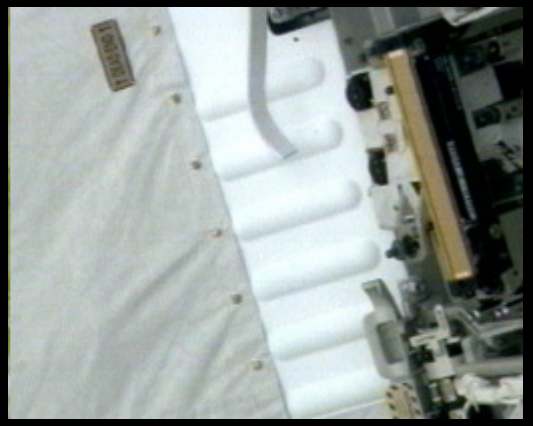
- 2 Crew EVA Without IVA Crewmember
- No Advanced Life Support (ALS)
- CMG RPCM Repair
- Probabilistic Risk Assessment (PRA) for “Zero vs. Two vs. Three Crewmembers”, “Two Crew EVA with no IVA Crewmember” used by ISS Program Manager to make a risk informed decision
- “Single Seal Quick Disconnect Study” PRA trade study that is now referenced Agency Wide by the payload community as an alternative to implementing failure tolerance
- Hatches Closed vs. Open During Soyuz Relocation
- Soyuz Seat Liners in Shuttle Middeck vs. the MPLM

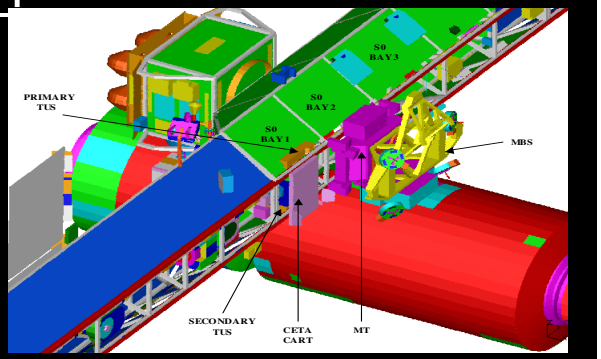


ISS PRA Trade Studies

(continued)

- New Design Interface Heat Exchanger
- Effects of Additional EATCS Pump on ISS End-states
- Loose HTV FRGF With Hot Redundant SSRMS
- FGB Loss of Power
- Potential ISS Failures with Immediate Catastrophic Consequences Comparison With Orbiter RJD Failure
- Assessment of Progress & Soyuz Collision Scenarios
- ISS Contingency Shuttle Crew Support (CSCS) O2/CO2/H2O Risks for LF-1 Launch – 6, 3 and 1 month(s)
- Orbiter Docking Risk Drivers
- MT MMOD risk trade





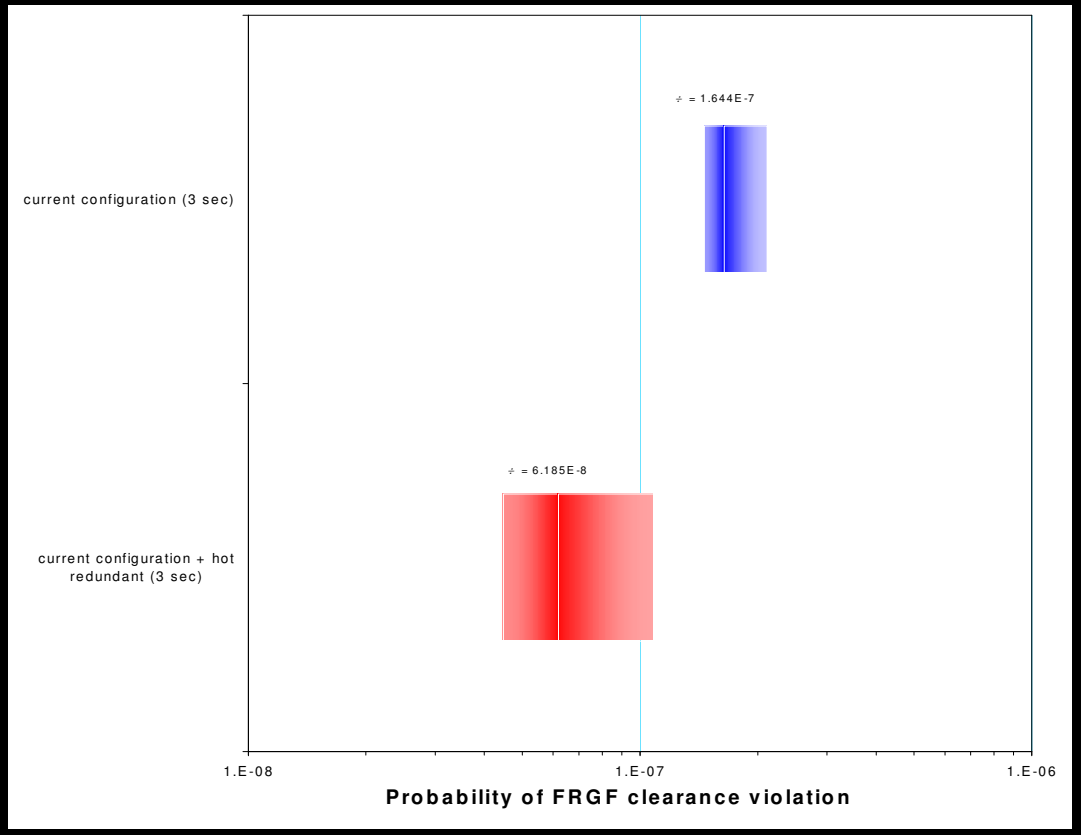
ISS PRA Trade Studies
(continued)

- Six crew scenarios with limited EVA capability
- HTV Bump collision evaluation
- EVA with SAFER and without SAFER trade
- Six crew and one Soyuz
- S-Band risk and sparing study

Loose HTV FRGF With Hot Redundant SSRMS

(September 2004)

- HTV must be grappled by SSRMS for CBM berthing of the vehicle to ISS
- If snaring is stopped before complete capture of the FRGF, HTV could collide with SSRMS and/or ISS
- If FRGF is separated to prevent collision hazard, an unsnared FRGF could float out of LEE and contact ISS
- Proposed SSRMS “hot redundant” configuration would permit quickly switching to a redundant power/control to permit completion of snaring/ grappling should the primary fail



Question:

- What is the risk of loose FRGF contact with ISS?

Answer:

- The option considered significantly improves the overall risk of recontact

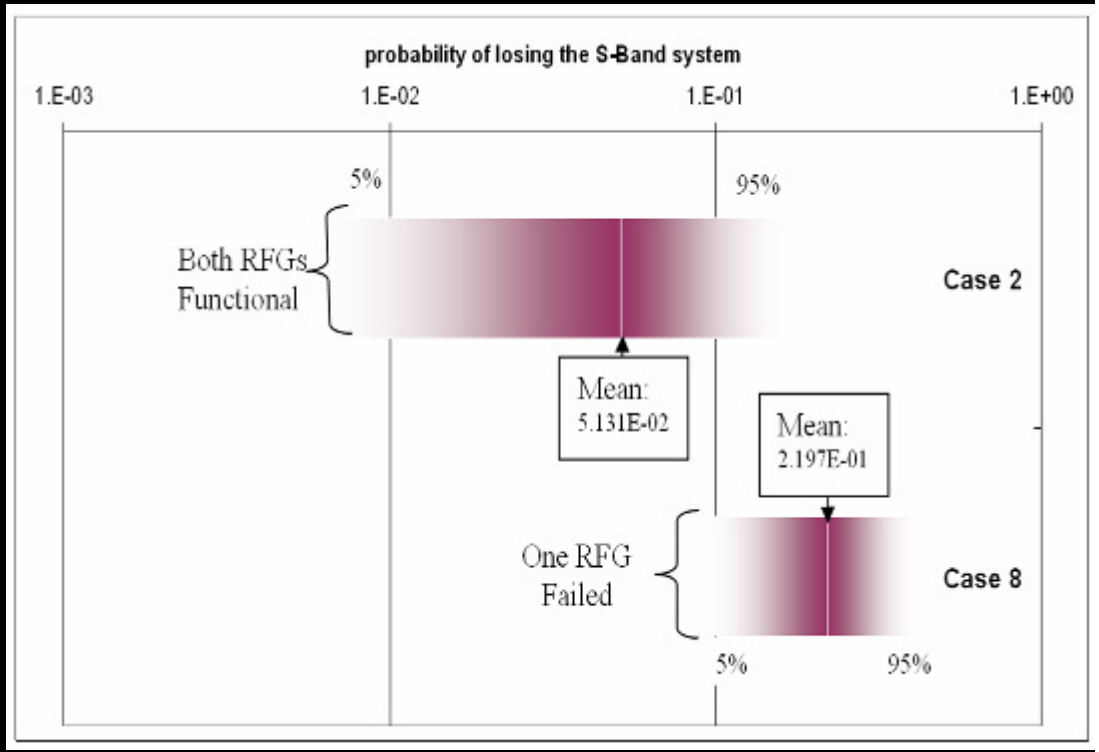
Loss of the S-Band System

(January 2007)

- Recently, string 1 forward link of the S-Band communication system has been operating intermittently and showing signs of failure
- The exact cause of this behavior is not completely known as of the time of this study, but is assumed to be within the Radio Frequency Group (RFG)
- The remaining S-Band string is approaching the end of its design life
- There are no existing spares on the ground or on orbit

Question:

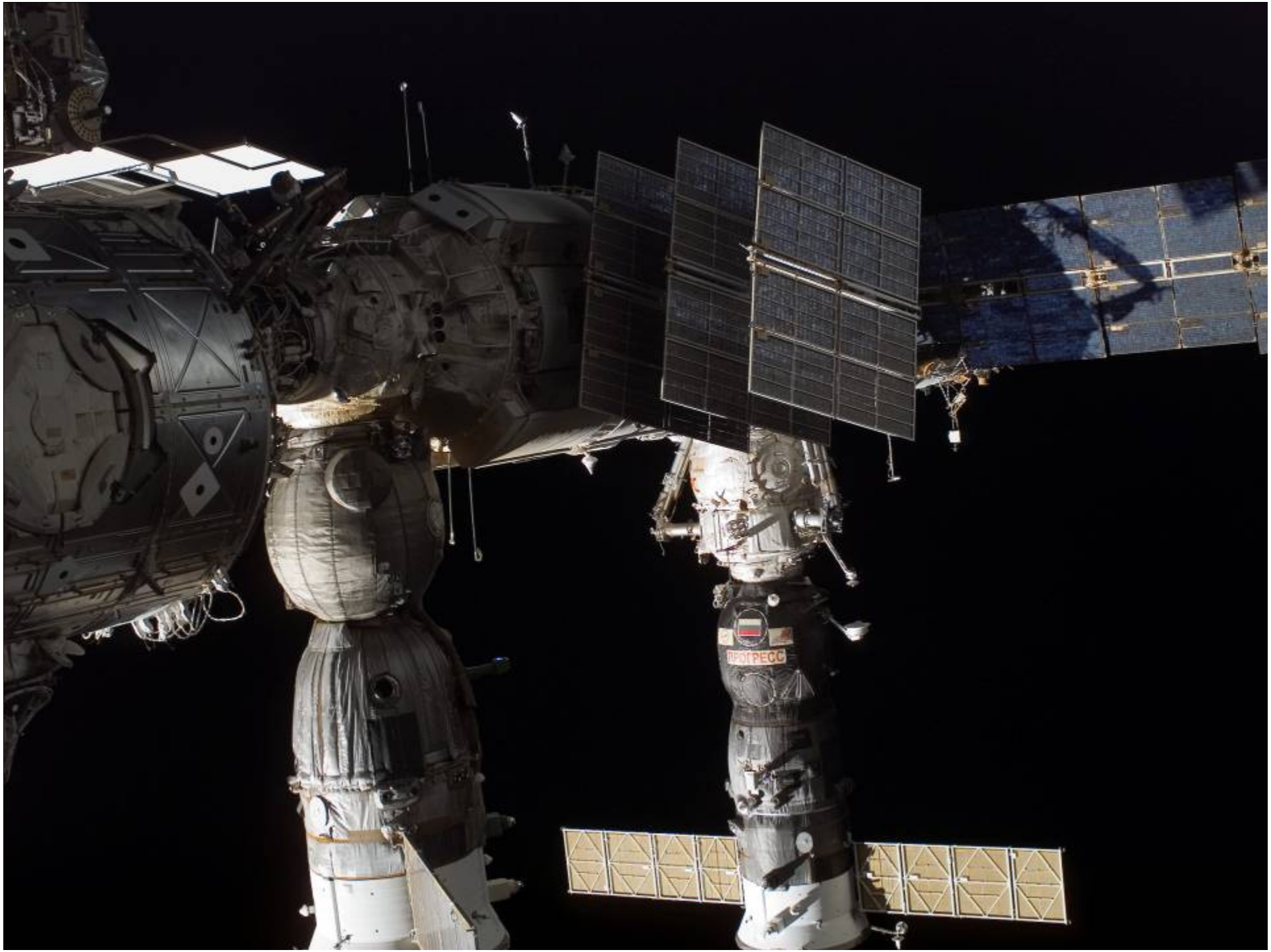
- What is the probability of losing the remaining fully functional string of S-Band?



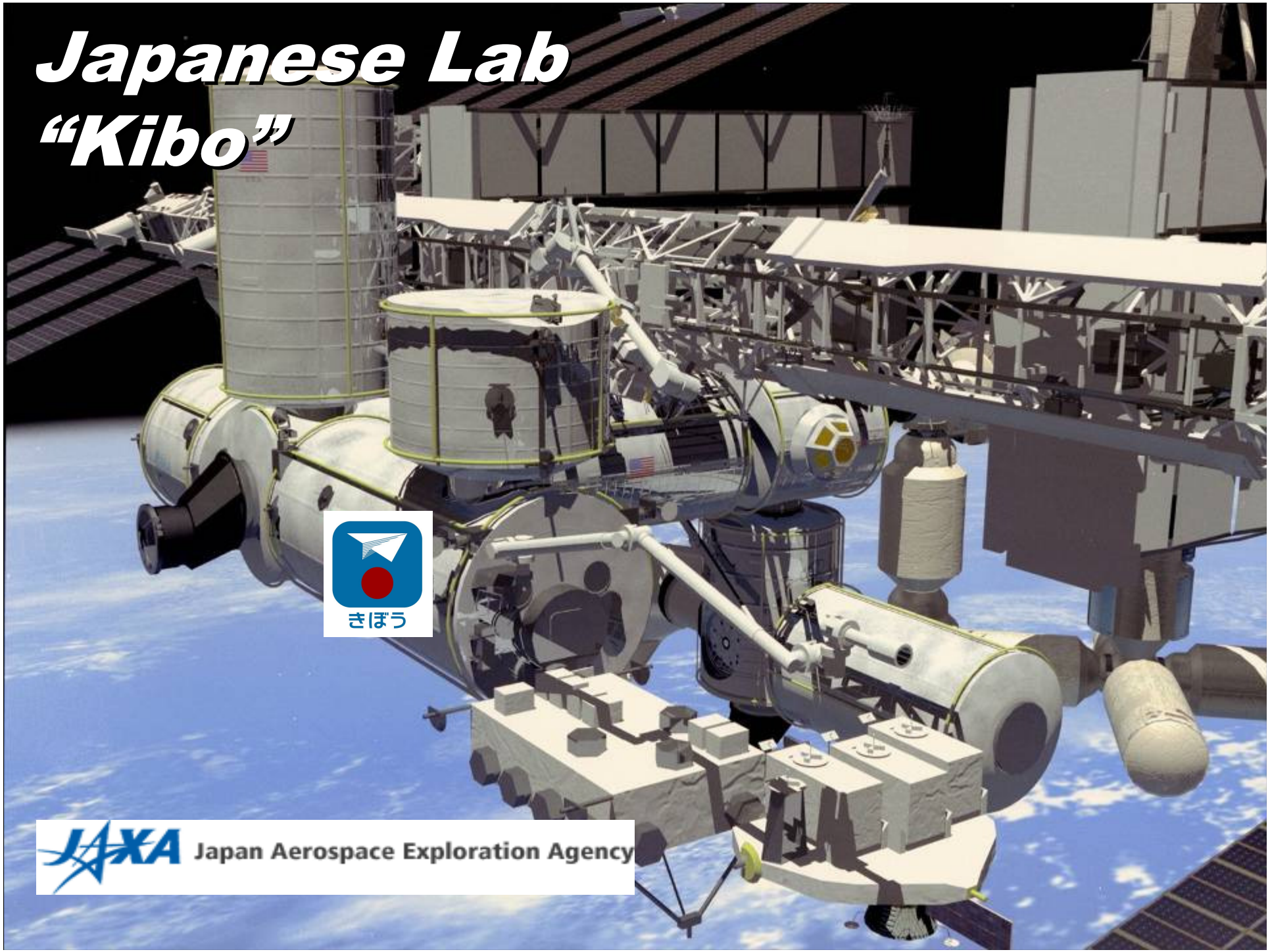
Answer:

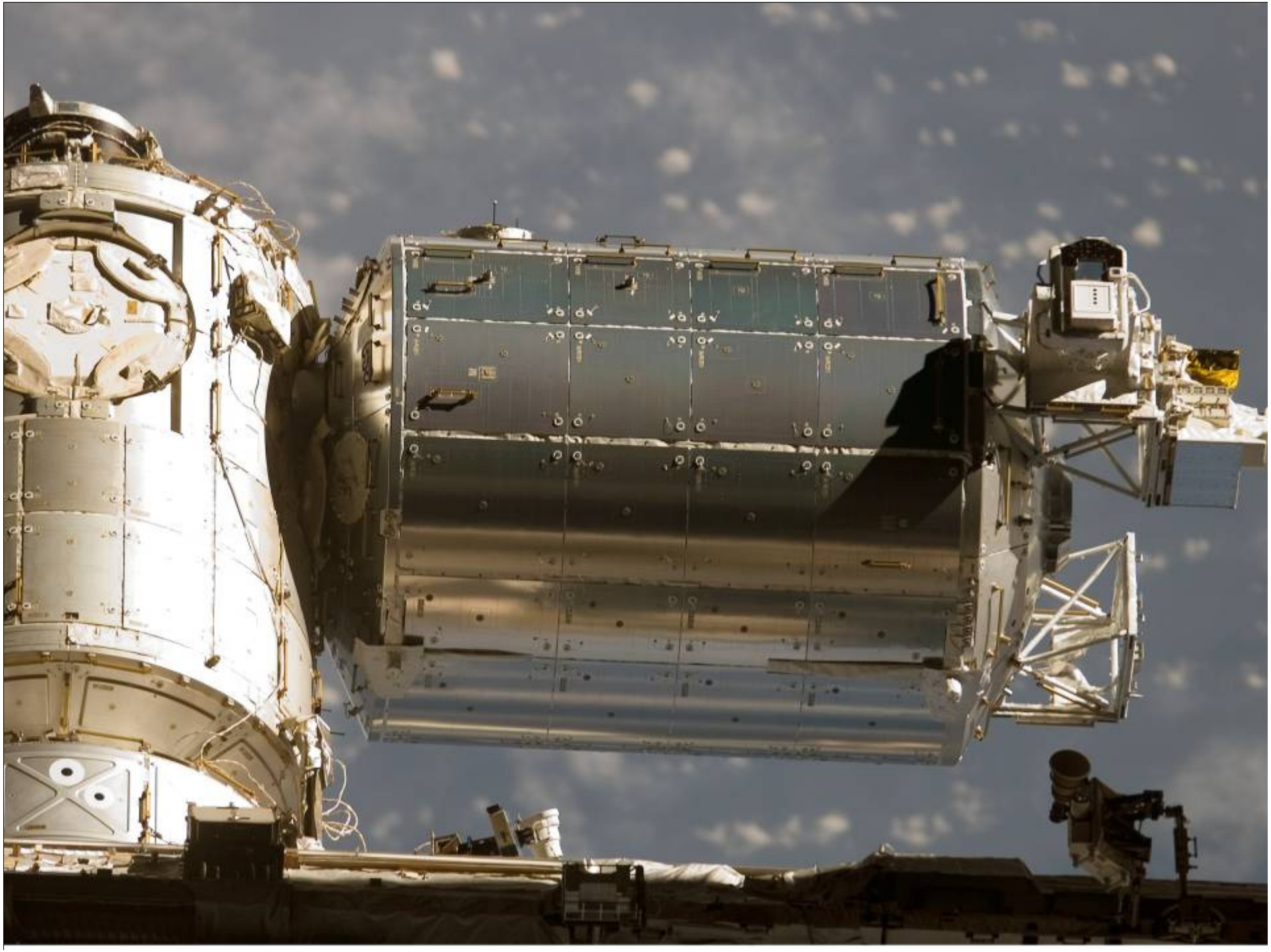
- The effects of losing the entire S-Band system are over 4 times more likely if another string is lost

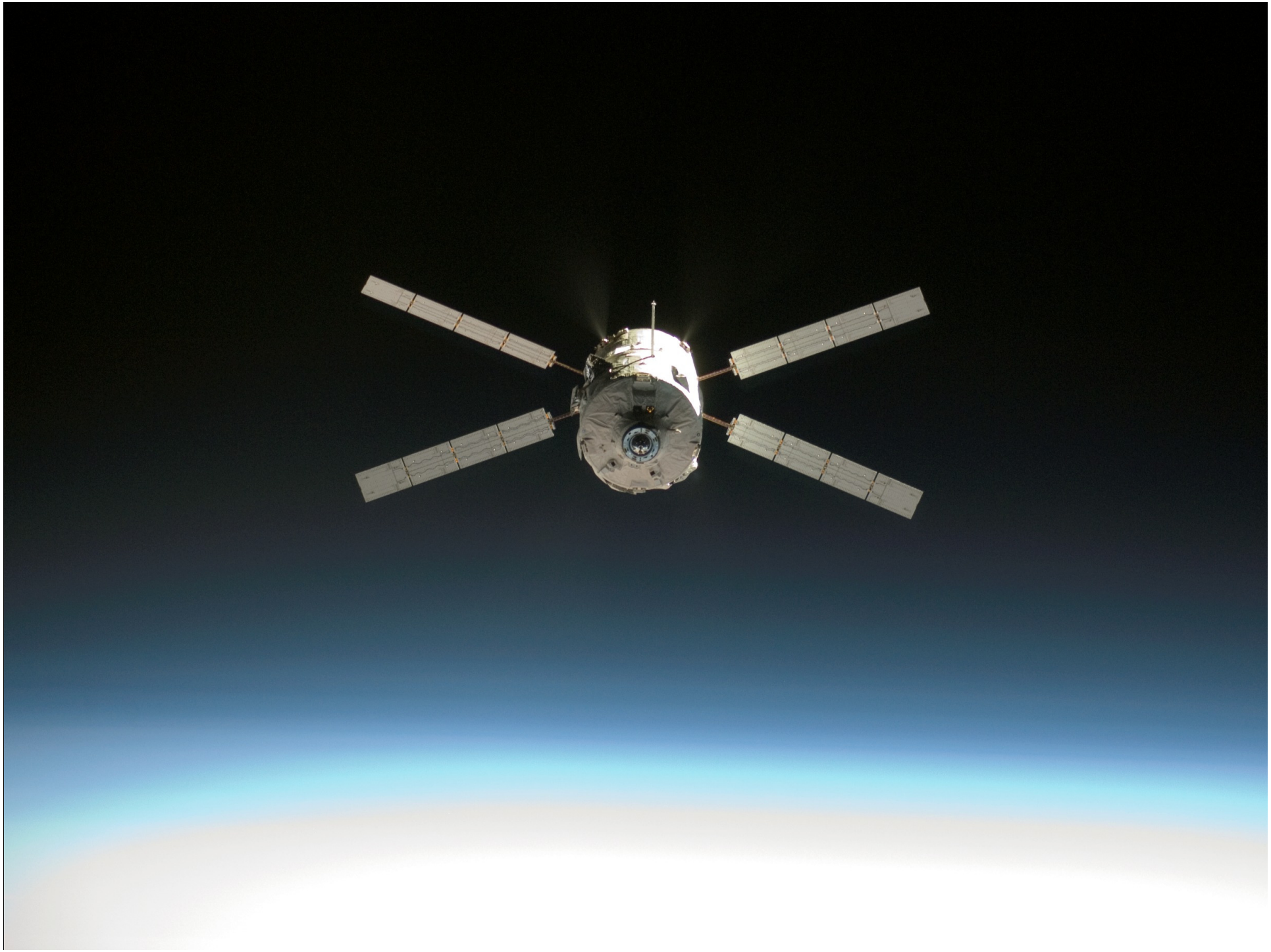
Scope – IP Elements

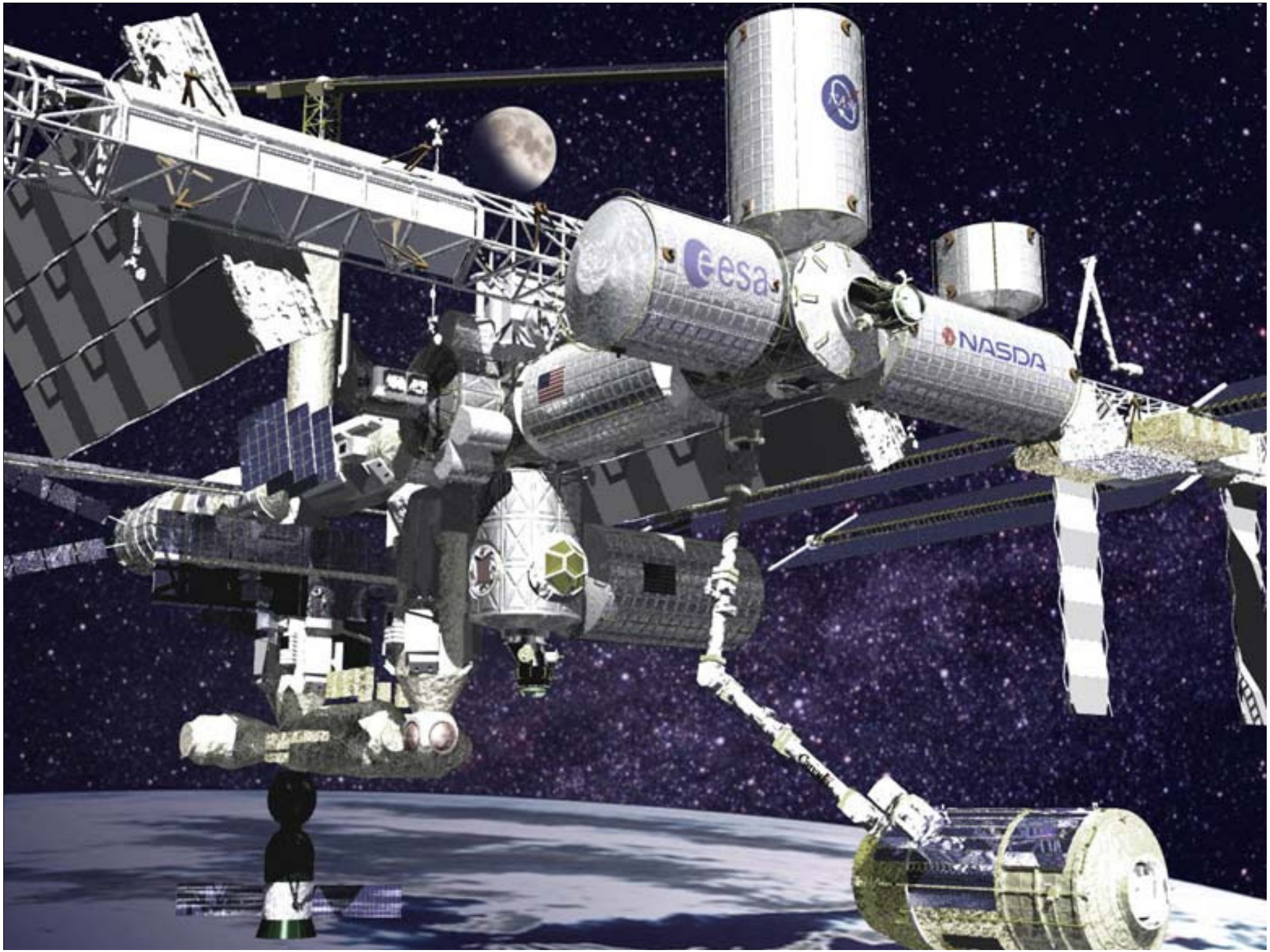

ПРОГРЕСС

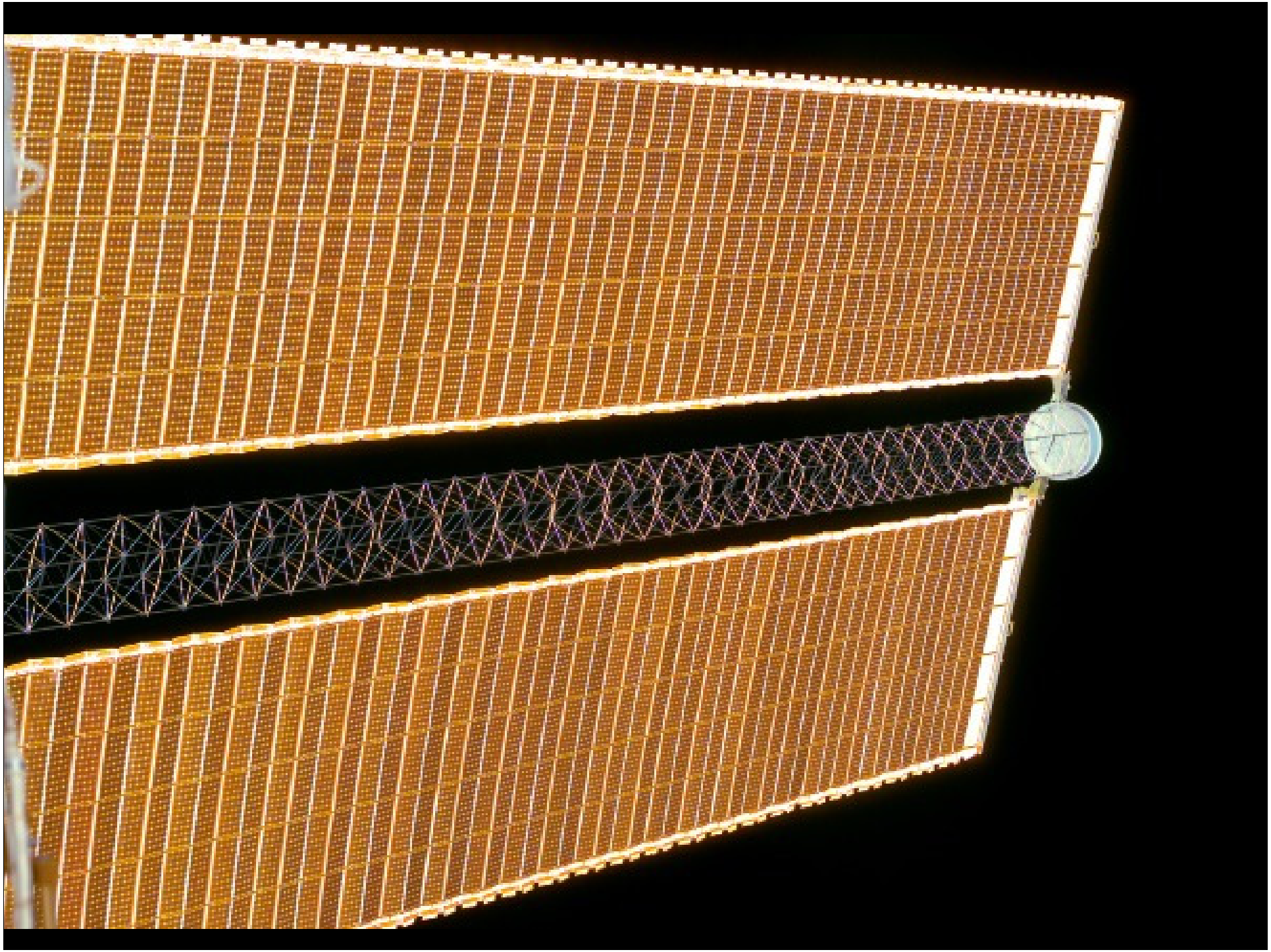
Japanese Lab "Kibo"



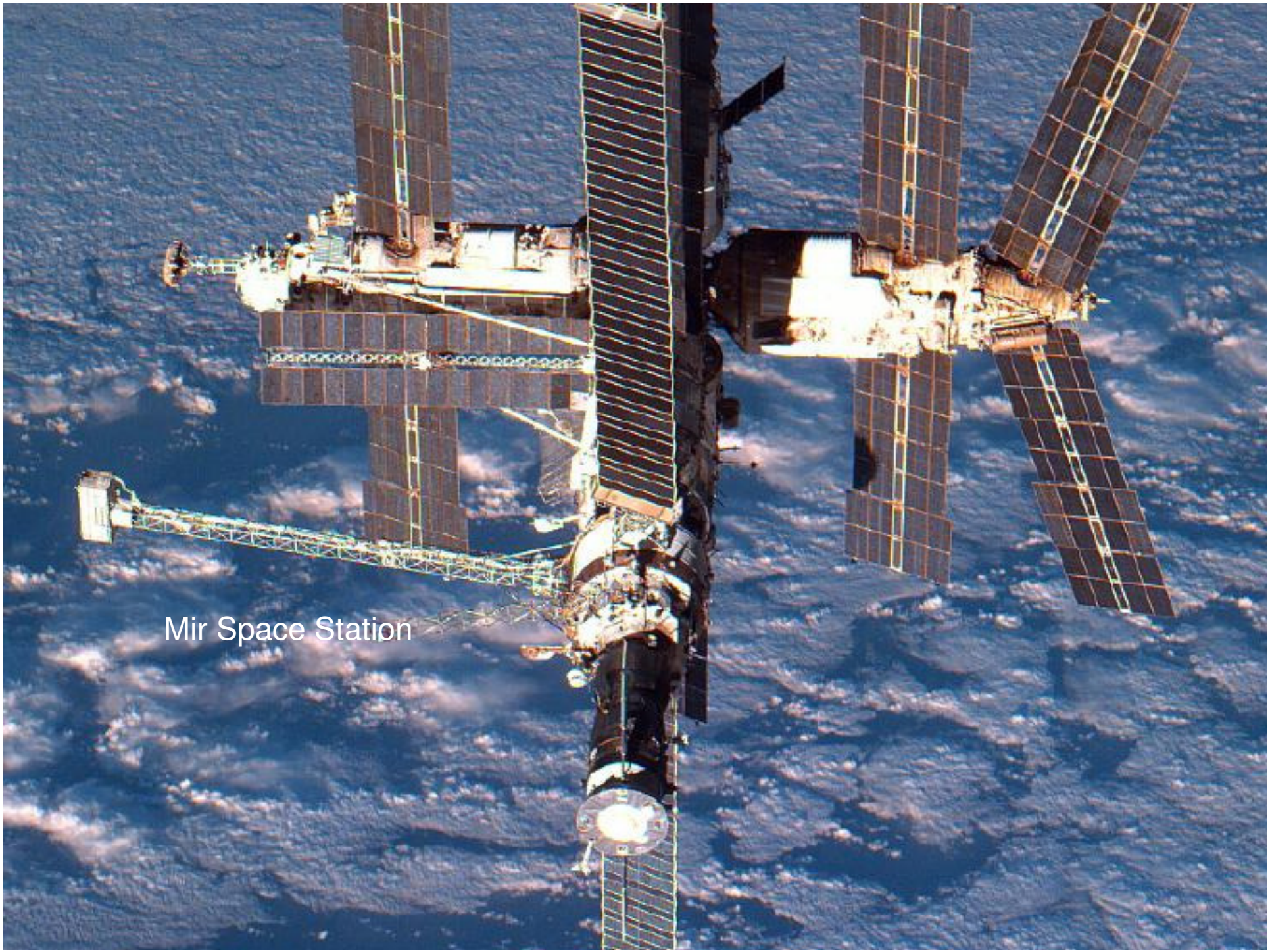





esa
NASDA



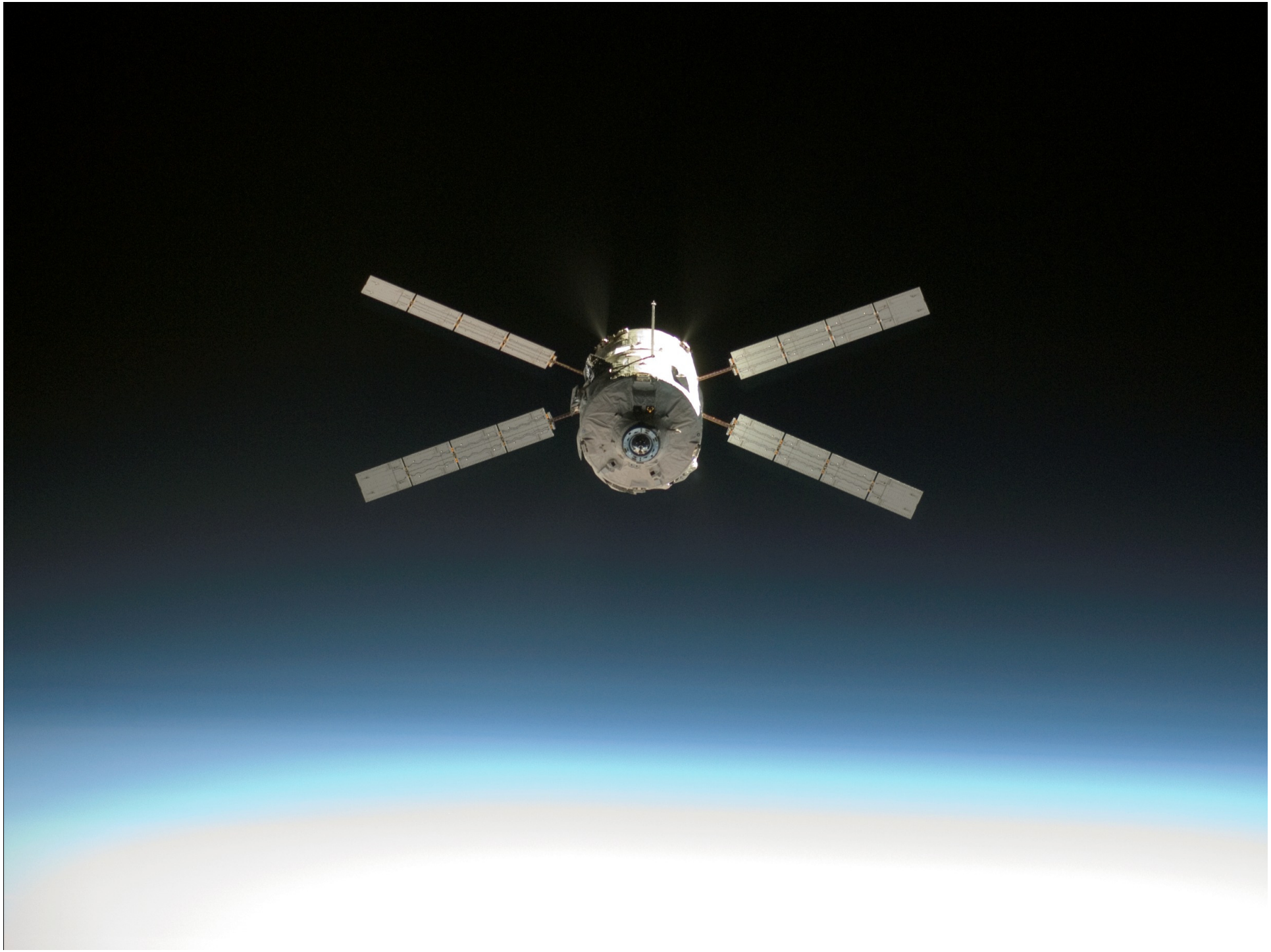

ENKO CLOTHING
26P


Mir Space Station

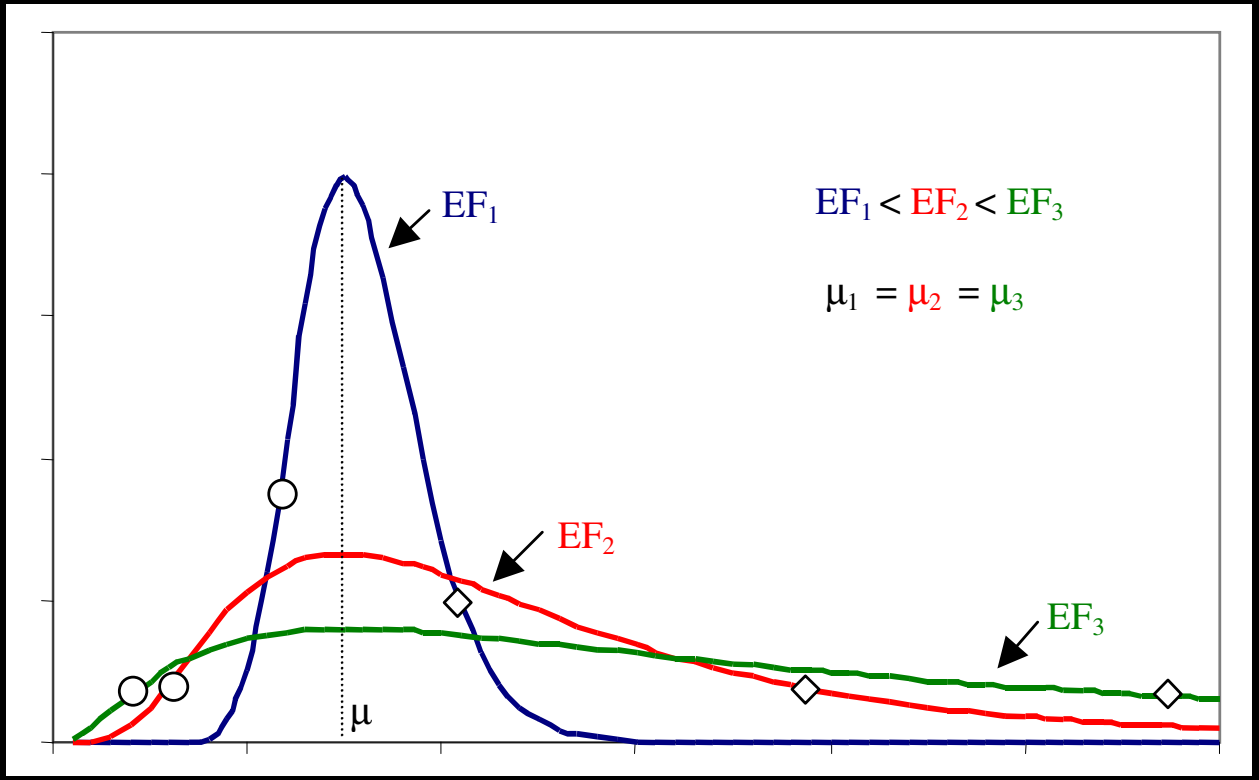
European Lab "Columbus"

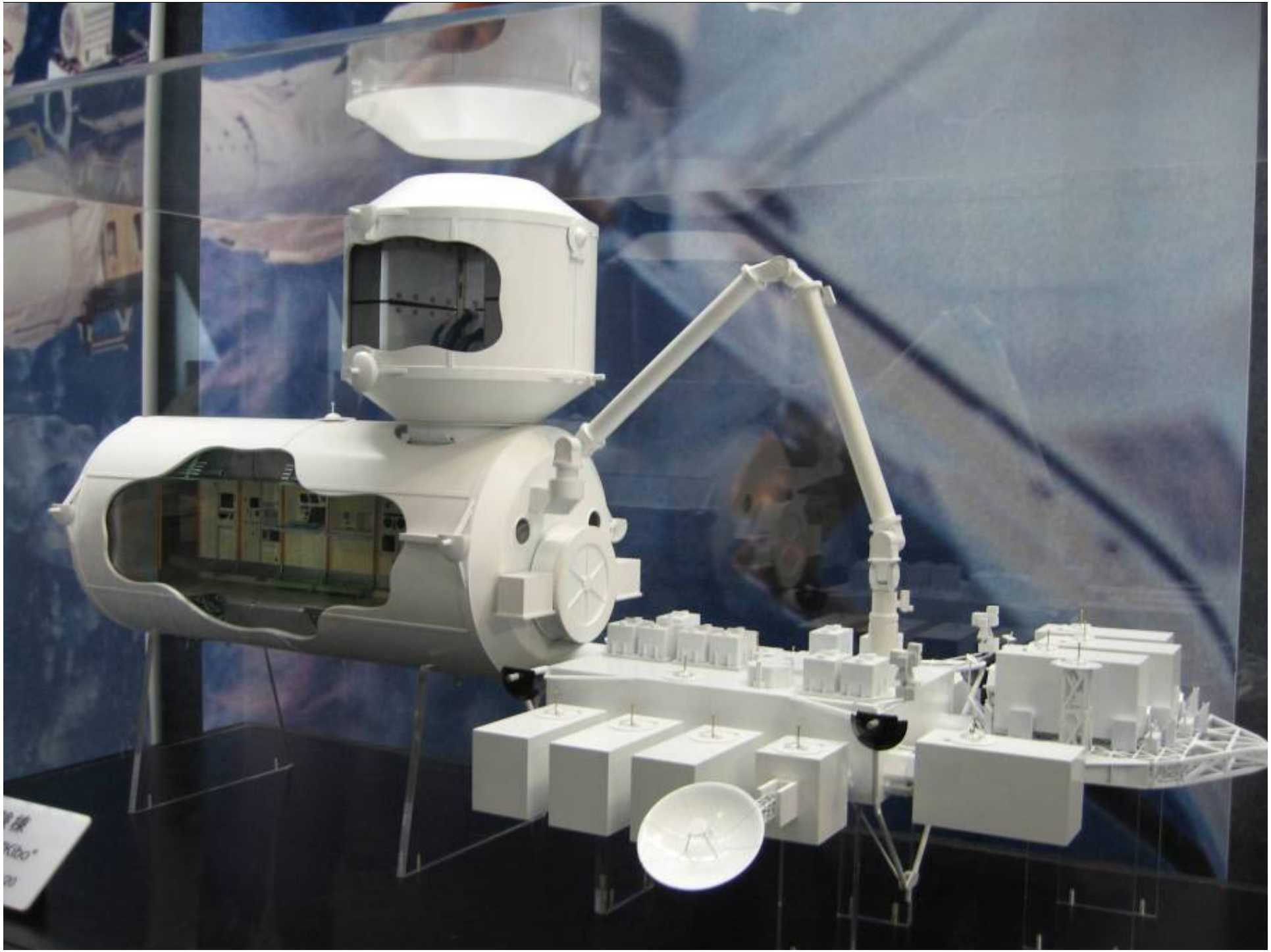
esa

European Space Agency

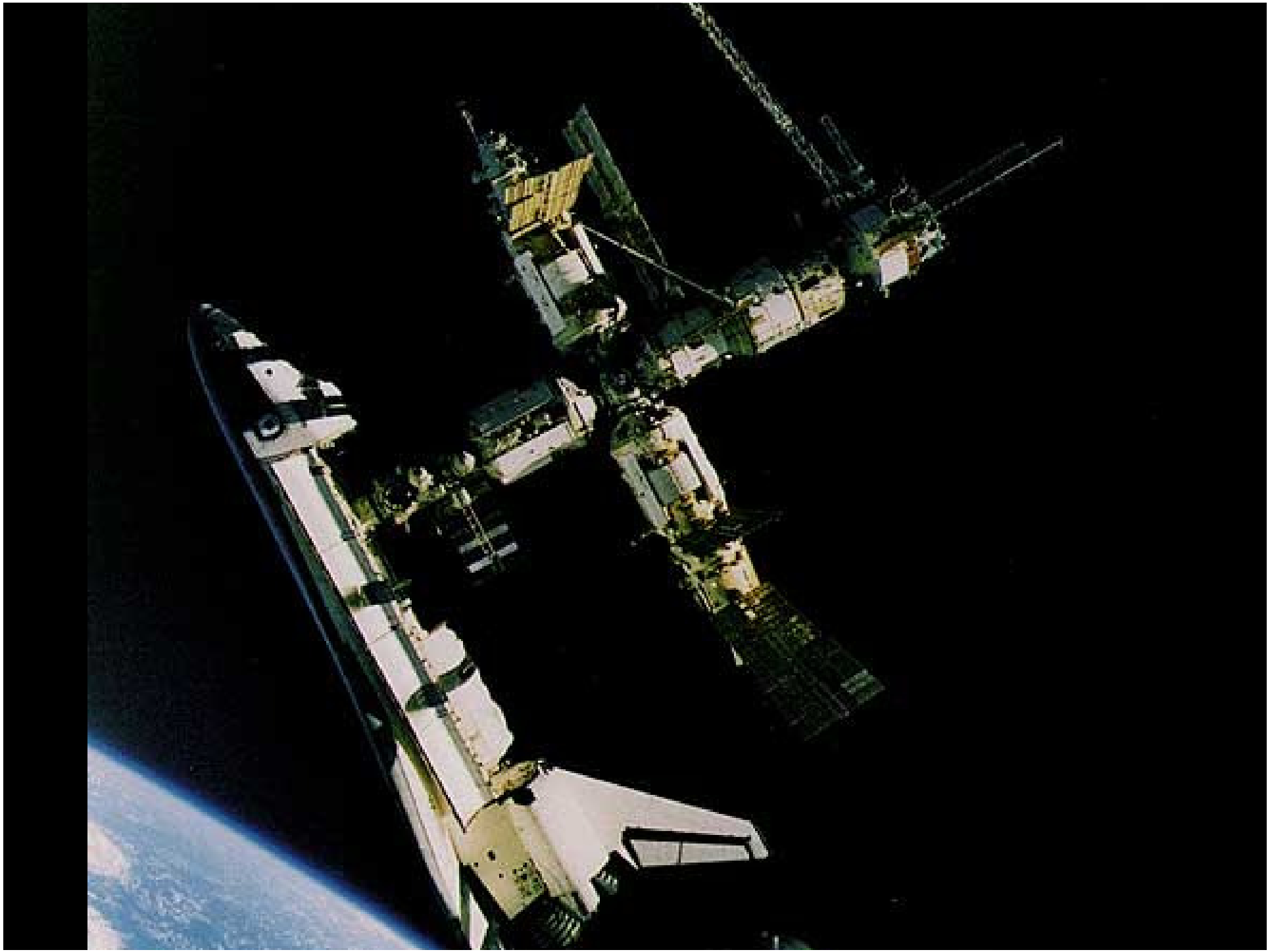


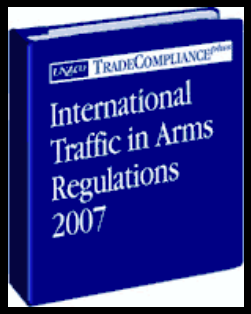
Failure Rates from Modeling Analysis Data Set (MADS) and Bayesian Updating






JAXA





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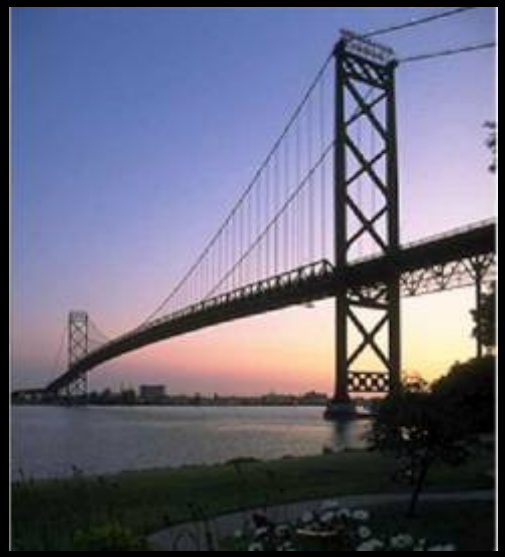

1995

1995

2008


Enjoy your life!
Enjoy your socks style!
tutuanna*


整理整頓
MAINTAIN ORDER